Riverbank Characterization Work Plan
Terminal 4 Action Area
Portland, Oregon

Prepared for: Port
of Portland

September 4, 2020
2372-07

APEX

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REGISTERED PROFESSIONAL
OREGON
STEVE D. MISNER
G1749
GEOLOGIST

Exp. 5/31/2021

Steve Misner, R.G.
Senior Associate

REGISTERED PROFESSIONAL
ENGINEER
15,147 PE
OREGON
OCT. 2, 1990
HERBERT F. CLOUGH

EXPIRES: DEC. 31, 2021

Herb Clough, P.E.
Principal Engineer

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1.0 Introduction

This Riverbank Characterization Work Plan (Work Plan) was prepared by Apex Companies, LLC (Apex) on behalf of the Port of Portland (Port) for the Terminal 4 Facility (T4), located on the east bank of the Willamette River between river miles (RM) 4.2 and 5.0 in Portland, Oregon (Figure 1). This Work Plan was prepared in accordance with the United States Environmental Protection Agency (EPA) Guidance for Riverbank Characterizations and Evaluations at the Portland Harbor Superfund Site (the Guidance; EPA, 2019). The Guidance is to be considered for source control and remedial design processes for riverbanks within the Portland Harbor Superfund Site (PHSS).

In addition to riverbank characterization, this Work Plan describes surface sediment sampling to be completed in an area that was inaccessible during the T4 Pre-Remedial Design Investigation conducted in 2019 by Anchor QEA (Anchor) (Anchor, 2019b).

1.1 Purpose and Objectives

This Work Plan for riverbank characterization builds upon previous investigations and evaluations for source control at T4 required by the Oregon Department of Environmental Quality (DEQ) pursuant to the following:

- T4 Slip 1 Upland Facility – Voluntary Agreement for Remedial Investigation, Source Control Measures, and Feasibility Study (DEQ No. LQVC-NWR-03-18), December 4, 2003; and
- T4 Slip 3 Upland Facility – Consent Judgement No. 0410-10234, Multnomah Circuit Court, October 7, 2004.

The purpose of the riverbank characterization is to evaluate whether bank erosion and transport are a significant pathway for recontamination of the Willamette River PHSS sediments. Consistent with the Guidance, riverbank characterization requires the chemical and physical characterization of the riverbank. Chemical characterization includes the development of a detailed conceptual site model (CSM) based on a review of existing site information and previous investigations. The CSM is used to guide the sampling and analysis plan to delineate the nature and extent of contamination in the riverbank relative to applicable screening criteria. Following the chemical characterization, the riverbank will be characterized for erodibility potential.

The purpose of the surface sediment sampling is to complete the sampling and analysis described in the Pre-Remedial Design Investigation (PDI) Work Plan (Anchor, 2019a). The sediment sampling is intended to refine the understanding of the nature and extent of contamination in the surface sediments (i.e. 0 to 30 centimeters [cm] below the mudline [bml]). The majority of historical surface sediment data at T4 is believed to be outdated and no longer representative of current surface sediment conditions. Results will be used to refine the lateral extent of contamination and further delineate sediment management areas (SMAs).

The objectives of the Work Plan include: (1) Refine the CSM; (2) Delineate the extent of contamination in riverbank soils relative to applicable screening levels; (3) further delineate SMAs; and (4) identify physical characteristics of the riverbank and prepare an erodibility evaluation.

Erosion along the riverbank will then be evaluated as a potential pathway for recontamination of PHSS sediment and possible remedies will be considered for T4, if necessary.

1.2 Regulatory Framework

T4 is located along the Willamette River within the PHSS. The PHSS extends from RM 1.9 (upriver end of the Port's Terminal 5) to RM 11.8 (near the Broadway Bridge).

This Riverbank Characterization Work Plan has been prepared under the ASAOC (Docket No. Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] 10-2004-0009), as amended on June 21, 2018, and in the *Remedial Design Statement of Work* (SOW; EPA, 2018). Per the SOW, this Work Plan presents pre-remedial design data gaps and the field investigations will be used to evaluate recontamination potential of riverbank erosion and to support SMA delineation.

In 2017, EPA published the PHSS Record of Decision (ROD) that presents the selected remedy to address all contaminated media and complete exposure pathways posing unacceptable risk to human health or the environment, including sediment, biota, surface water, groundwater, and riverbanks. The ROD defined sediment decision units (SDUs) as separate areas of the PHSS that generally include the highest concentrations of focused contaminants of concern (COC) over a one river mile segment. T4 is adjacent to the River Mile 4.5 E (RM 4.5E) SDU (Figure 1). The focused harbor-wide COCs for the PHSS include:

- Polycyclic aromatic hydrocarbons (PAHs);
- Total polychlorinated biphenyls (PCBs);
- DDx (the sum of dichlorodiphenyltrichloroethane [DDT], dichlorodiphenyldichloroethane [DDD], and dichlorodiphenyldichloroethylene [DDE]); and
- Dioxins/furans (specifically 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD]; 1,2,3,7,8 pentachlorodibenzo-p-dioxin [PeCDD]; and 2,3,4,7,8-pentachlorodibenzofuran [PeCDF])

ROD cleanup levels (CULs) were developed for the PHSS COCs. These are the concentrations that must be achieved within a reasonable timeframe by the selected remedy. Remedial action levels (RALs) were developed in the ROD for focused COCs and were established to define areas in which active remediation (such as containment or removal technologies) would be required. In 2019, the RAL for total PAHs was refined for the Site per the PHSS Explanation of Significant Differences (ESD). Data presented in this Work Plan are compared to the CULs presented in Table 17 of the ROD as updated by the errata from January 2020, ROD RALs, and ESD RALs.

The areas defined by RAL concentrations are SMAs. The ROD SMAs within the T4 SDU, and the large majority of site risk, are defined by concentrations of total PAHs and PCBs that exceed RALs. These are the site-specific focused COCs that EPA identified for T4, per Table 24 of the ROD. The remedial technologies applied to the T4 SDU will likely include capping, dredging, sediment treatment (e.g. activated carbon placement), natural recovery, or a combination of these technologies.

The ROD Section 14.2.5 defines the riverbank region as "areas from top of bank down to the river that may be contaminated along the shoreline next to contaminated in-river shallow areas". The shallow region was defined in ROD Section 14.2.4 as the area shoreward of the river bed elevation of approximately minus 2 feet (-2 feet) Columbia River Datum (CRD).

In September 2019, EPA developed the Guidance for the characterization, evaluation, and cleanup of riverbank soil/sediment to be consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements of the PHSS ROD and with the Oregon Department of Environmental Quality (DEQ) upland source control program as guided by the Joint Source Control Strategy (JSCS; DEQ/EPA, 2005).

The Guidance further defined riverbanks to be classified into one of three categories: ROD riverbanks; riverbanks pending characterization; and JSCS riverbanks. ROD riverbanks comprise those contaminated riverbanks listed in ROD Section 6.6.6 and shown on ROD Figures 9 and 30 (EPA, 2017a). Riverbanks pending characterization include properties with riverbanks adjacent to an SMA which might not have been individually identified in the ROD and that have information obtained from the DEQ's Environmental Cleanup Site Information (ECSI) database. JSCS riverbanks relates to riverbank areas managed with DEQ authority that were not identified as being contiguous with or adjacent to SMAs.

In the Guidance, the T4 riverbank is categorized as a riverbank pending characterization. These riverbank areas are subject to change based on potential changes to SMA delineation during remedial design or data collection. If further assessment/delineation of the SMA identifies sediment contamination contiguous with riverbank contamination, then the T4 riverbank will be considered a ROD riverbank and will be subject to the ROD riverbank requirements.

1.3 Report Organization

This document is organized in the following manner:

- Section 2 provides a description of T4, T4 history, releases and potential sources, previous investigations, and remedial actions.
- Section 3 presents the current CSM addressing geology, hydrogeology, nature/extent of contamination, and chemicals of interest.
- Section 4 presents the plan for evaluating chemical characteristics of the T4 riverbank.

- Section 5 presents the plan for evaluating the physical characteristics of the T4 riverbank, to include the results of a site reconnaissance, topographic survey, review of existing site information, and an erodibility evaluation.
- Section 6 presents the proposed schedule and reporting deliverables.
- Section 7 lists the references cited in this Work Plan

2.0 Site Description and History

2.1 Site Description

T4 covers approximately 260 acres in the St. Johns area of North Portland at 11040 N. Lombard Street. The location and vicinity of T4 are shown on Figure 1. T4 is located on the east bank of the Willamette River between River Miles 4.2 and 5.0. The land is zoned for industrial use (IH). The areas surrounding T4 are occupied by marine, industrial, and commercial operations. A small residential zone (four tax lots) is located about 200 feet east of the terminal. Larger residential zones are located 2,000 feet east and 1,000 feet southeast of the terminal.

The topography of T4 is relatively flat, with the majority of the terminal at an elevation of approximately 35 feet (all elevations in this work plan are in NAVD88 unless otherwise noted). The terminal entrance (east portion of the terminal near Lombard Street) is at an elevation of approximately 100 feet. The ground surface of the terminal consists of asphalt or cement concrete pavement, buildings, and areas of interspersed gravel and grass. Three inlets from the Willamette River are present in the northern portion of T4: Slip 1 to the north, Slip 3 to the south, and a smaller bay between the two slips informally referred to as Wheeler Bay (see Figure 2).

The upland area of T4 was divided into three areas for the purposes of oversight of investigation and/or cleanup by the DEQ Environmental Cleanup. The three areas are designated as T4 Slip 1 (ECSI No. 2356), T4 Slip 3 (ECSI No. 272), and T4 Auto Storage Area (ASA; ECSI No. 172). These areas encompass 98 acres, 27 acres, and 102 acres, respectively. The approximate boundaries of these regulatory areas are shown on Figure 1. The ASA received a No Further Action (NFA) determination from DEQ on June 11, 2004; this area is not included in this Work Plan.

2.1.1 Terminal 4 Slip 1

T4 Slip 1 is located at the northern end of the terminal and is bound to the north by the Schnitzer Steel Products and the Northwest Pipe Company properties; to the east by the T4 property boundary (i.e. N Lombard Street and the Union Pacific Railroad [UPRR] right-of-way); to the south by Wheeler Bay, Slip 3, and the Slip 3 Upland Facility; and to the west by the ordinary low water line (OLWL). The Port also owns approximately 11 acres of the submerged lands below the OLWL in Slip 1.

2.1.2 *Terminal 4 Slip 3*

T4 Slip 3 is bounded to the north by the Slip 1 Upland Facility; to the east by the T4 property boundary (i.e. N Lombard Street and the UPRR right-of-way); to the south by the T4 ASA; and to the west by the OLWL. The Port also owns approximately 6-acres of the submerged lands below OLWL in Slip 3.

2.2 Historical Site Use

The following historical discussion is reproduced from the 2000 Remedial Investigation (RI) Report for T4 Slip 3 Upland Facility (Hart Crowser, 2000) and the 2007 RI Report for T4 Slip 1 Upland Facility (ACA/NF, 2007) unless otherwise referenced.

Initial development of the area began in 1907 and 1908, with the construction of the UPRR along the eastern edge of the river floodplain. By 1912, UPRR had constructed its oil-supply dock and the St. Johns Tank Farm for fueling locomotives. The City of Portland Commission of Public Docks (City CPD) purchased the property west of the railroad (generally river floodplain) in 1917 as part of the original 117.55-acre site for the St. Johns Municipal Terminal. This included approximately 36 acres of submerged land around the former Gatton Slough, which entered the river near the head of Slip 1. Development of the terminal resulted in the filling of Gatton Slough and adjacent areas within the river, and excavation of Slip 1.

In 1920, the quay and bulk handling facility at Pier 5 and Berth 412 were constructed. Pier 4, containing Berths 410 and 411, was constructed in 1955 and outfitted with Whirley cranes. The cranes were removed in 1984. The bulk outloader Dravo was commissioned at Berths 410 and 411 in 1961. The use of the Dravo ended in 1998. The wharf at Pier 5 was removed in 1962, and the bulk outloader was decommissioned in 1990. The wharf at Berth 412 was removed in 1997. The location of the piers and berths are shown in Figure 2.

The Port acquired the T4 property in 1971 as a result of the Port's merger with the City CPD. In 1972, the Port purchased a strip of land along the northern property line from Broadway Holding Company in connection with the relocation of the grain berth to the face of current Berth 401. The Port leases portions of the T4 to various tenants and multiple tenants have been present at T4 historically since its construction in the early 1900s.

Historical operations at T4 Slip 1 have included loading, unloading, processing, and storage of grain; handling of bulk cargos such as wool, cotton, and natural rubber; cold storage of food; fumigation of cotton and food products; liquid storage (*i.e.,* fertilizer, molasses, tallow, urea, caustic soda, and fats); flour milling; container food freight; a gasoline station; salvage yard; operation of a break-bulk berth; fire boat moorage and importing lead and zinc ore concentrations.

Historically, the berthing areas at Slip 3 have been used for bulk cargo loading and unloading operations. Products handled at the Slip 3 berths have included petroleum products, soda ash, talc, sulfur, zinc, lead and copper ores/concentrates, bentonite clay, coal, coke, and iron briquettes. Within Slip 3, bulk operations at

Berth 412 were terminated in 1989. Currently, only Berths 410 and 411 are in use for handling soda ash. Pencil pitch was imported through Berths 410 and 411 of Slip 3 and handled at the adjacent Slip 1 upland area from 1979 to 1998.

Pier 5 was historically used as a bulk loading facility that handled diesel oil, coal, and iron, zinc, and copper ores. Diesel oil was handled by an underground pipeline that extended from the face of Pier 5, under Berth 412, to above ground storage tanks (ASTs) off-site east of T4. The bulk ore shipments were moved by conveyor to ship loaders at Pier 5 and Berth 412. The location of the piers and berths are shown in Figure 2.

2.3 Current Site Use

T4 is currently used as a marine facility and has five water-related areas within RM 4.5E, shown on Figure 2 and summarized as follows:

- Berth 401 – This is an active berth in the main river north (downstream) of Slip 1.
- Slip 1 – This has no existing water-dependent uses, and future uses are planned to be limited to shallow-draft barge use. Slip 1 contains two piers (Pier 1 and Pier 2) and three berths (405, 408, and 409).
- Wheeler Bay – This is an inactive bay with no current water-dependent uses and no anticipated future uses. Stabilization of the Wheeler Bay shoreline occurred as a source control measure during the 2008 T4 Phase I Removal Action (Anchor, 2009).
- Slip 3 – This contains Pier 4 with Berths 410 and 411 that are the main site of active marine operations (80% occupancy) serving deep-draft, ocean-going vessels. Berths 410 and 411 are located along the north side of Slip 3; the south side (i.e. former Pier 5) is inactive.
- Berth 414 – This is an active berth in the main river south (upriver) of Slip 3. It is used to unload automobiles from deep-draft, ocean-going vessels to the ASA located in the southern portion of T4.

As mentioned above, T4 Slip 3 has two active berths (410 and 411) on Pier 4. Current operations consist of loading, unloading, and handling of soda ash cargo. Soda ash operations, currently leased by Kinder Morgan Bulk Terminals (KMBT), include railroad tracks, conveyor system with associated buildings, a 30,000 metric ton storage building, and a maintenance warehouse with offices. Slip 3 also contains rail trackage which crosses the northern portion of T4. The soda ash is loaded onto ships at Berths 410 and 411. The following ASTs, underground storage tanks (USTs), and water retention structures are present at the KMBT leasehold:

- 500-gallon steel used oil AST
- 500-gallon steel gasoline AST
- 330-gallon poly tote for sulfuric acid
- 10,000- and 15,000-gallon ASTs for washwater

- 5,000-gallon fiberglass diesel UST
- 43,000-gallon concrete retention pond

Soda ash is the only cargo currently handled at Slip 3 and does not include chemicals that are COCs in Portland Harbor sediments. In addition, the cargo loading, unloading, and handling are conducted in accordance with best management practices (BMPs) to reduce the risk of releases to the river.

2.4 Potential Sources of Contamination

The historical research conducted for T4 identified past activities and features that may be areas of concern as contaminant sources. Based on the site history summarized in Section 2.2, Figure 3 summarizes potential source areas. Potential sources of contamination generally include:

- Historical and current areas of material handling and disposal;
- Historical spills and releases;
- Historical and current material storage, including ASTs and USTs; and
- Outfalls.

Slip 1 Upland Facility. The 2004 RI Proposal (URS, 2004) identified 77 potential sources of contamination, called areas of concern (AOCs), where hazardous substances may have been handled or managed at the Slip 1 Upland Facility. Available information on each of the AOCs was obtained and each was reviewed to determine whether further investigation was warranted. A total of 19 of the 77 AOCs were recommended for investigation of releases of hazardous substances. DEQ reviewed the RI Proposal and in a February 2004 letter, DEQ requested a revision to the AOC list. In accordance with DEQ comments, the RI Work Plan identified 42 AOCs for investigation. Subsequent to development of the RI Work Plan, seven additional AOCs were identified during a site walk. The 49 AOCs that were identified for additional investigation in the RI are listed below.

Operable Unit 1 (OU1)	Operable Unit 2 (OU2)
AOC 1 – Cargill UST – T-45	AOC 54 – Hall-Buck UST – T-24
AOC 5 – Cargill UST – T-22	AOC 57 – Kinder Morgan Former Railcar Wash Area
AOC 6 – Cargill UST – T-23	AOC 58 – UST – T-26
AOC 7 – Cargill UST – T-85	AOC 60 – City CPD UST – T-44
AOC 8 – Pesticide Use in Buildings 150 and 151	AOC 61 – Groundwater Seeps
AOC 9 – Railroad Track Staining Area	AOC 62 – Sloped Truck Scale with Sump
AOC 10 – Cargill Hydraulic Pump Area Staining	AOC 63 – Former Ore/Product Handling and Storage Locations
AOC 11 – Cargill Former Deep Well	AOC 64 – Former Leckenby Fumigation Plant
AOC 12 – General Pesticide Usage	AOC 65 – Former ATS Disinfestation Plant
AOC 13 – Former Transformer House	AOC 67 – Gearlocker and Maintenance Building
AOC 14 – Cargill Basement Level Sumps	AOC 68 – Boiler House
AOC 15 – Abandoned Cesspools	AOC 69 – Former PCB-Containing Transformer Locations
AOC 16 – Cargill Malathion Mixing Area	AOC 71 – Railroad Alignments
AOC 17 – Cargill Former Millwright Shop and Compressor House	AOC 73 – Berth 411 Pencil Pitch Handling
AOC 18 – Cargill Hydraulic Oil Releases	AOC 74 – Utility Storage Building
AOC 19 – Former Blacksmith Shop	AOC 75 – Former Car Cleaning Pit and Drain
AOC 20 – Cereal Foods UST – T-19	AOC 83 – Erodible Bank Areas
AOC 21 – Cereal Foods UST – T-20	
AOC 22 – Cereal Foods UST – T-21	
AOC 24 – Cafeteria Oil-Storage UST	
AOC 25 – Waste Pile	
AOC 26 – Former Gas Fueling Station	
AOC 27 – Former Transformer Handling Area	
AOC 28 – Possible Drum Burial Area	
AOC 29 – Schnitzer Auto Fluff Area	
AOC 69 – Former PCB-Containing Transformer Locations	
AOC 76 – Cargill Former Machinery Shop	
AOC 77 – Former Cold Storage Plant UST	
AOC 78 and AOC 80 – Storm Drain Catch Basins	
AOC 79 – Pump at Cargill with Hydraulic Oil Leak	
AOC 81 and AOC 82 – Waste Areas (Creosote)	

The 49 potential AOCs listed above were further assessed in this Work Plan for their potential to be a historical or ongoing source of contamination to riverbank soil or sediment. The evaluation considered location of material handling and/or storage with respect to the riverbank, known stormwater conduits that connect transport pathways to the river, and the nature of the material/contaminant. Of the 49 potential AOCs, 13 areas were identified as potential sources of contamination to riverbank soil and sediment. These areas are shown on Figure 3 and are summarized in the bullets below:

- The Abandoned Cesspools in the vicinity of the Cereal Foods buildings and the Cargill Leasehold area (AOC 15);
- Areas in the northwest corner of OU1 associated with the Railroad Track Staining Area (AOC 9) and the Auto Fluff Area (AOC 29);
- Pesticide use at the Cargill Leasehold Buildings 150 and 151 (AOC 8);
- The Former Gearlocker and Maintenance Building area (AOC 67);
- The Boiler House (AOC 68);
- Underground Storage Tanks located south of the Former Gearlocker and Maintenance Building (AOC 58 and 60);
- The Former Leckenby Fumigation Plant/Former ATS Disinfestation Plant (AOC 64 and 65);
- The Former Ore/Product Handling and Storage Locations (AOC 63);
- Erodible banks in the Wheeler Bay Riverbank Area (AOC 83; see Section 2.6.3 for stabilization efforts conducted at Wheeler Bay); and
- Berth 411 Pencil Pitch Handling (AOC 73).

In addition to the AOCs listed above, eight outfalls are located along the Slip 1 riverbank. Seven of these outfalls drain areas limited to the Slip 1 Upland Facility. City of Portland Outfall 52C, located at the head of Slip 1, drains approximately 2,500 lineal feet of roadway on Lombard Street and Roberts Avenue.

Slip 3 Upland Facility. Potential source areas at the Slip 3 Upland Facility include ore handling at Pier 5, the UPRR oil pipeline, the Quaker State canning facility, pencil pitch releases, and outfalls. Pier 5 was historically used as a bulk loading facility that handled diesel oil, coal, and iron, zinc, and copper ores. The bulk ore shipments were moved by conveyor to ship loaders at Pier 5 and Berth 412. The operations at Pier 5 were terminated in 1989 (Hart Crowser, 1998).

From at least 1920 to 1983, UPRR operated a petroleum pipeline crossing T4 within an easement (Hart Crowser, 2000) from Pier 5 and from the river side south of Slip 3. The 10-inch diameter steel pipeline was used to transfer diesel, No. 6 fuel, and Bunker C oil from marine vessels to bulk storage tanks located to the east. The pipeline configuration changed over time. The northern and oldest section of the pipeline was used until approximately 1971, and no formal abandonment was conducted. Petroleum hydrocarbon releases related to historical pipeline operations have occurred at T4. Figure 3 shows the locations of known and suspected release points from the pipeline/bulk storage tank system.

From 1953 to 1985, Quaker State operated an oil canning facility east of Slip 3 (Hart Crowser, 2000). ASTs were located at that site and were removed in 1985. An underground pipeline related to Quaker State was also removed.

Pencil pitch was imported through Berths 410 and 411 of Slip 3 and handled at the adjacent Slip 1 upland area from 1979 to 1998 (Hart Crowser, 1999). Riverbank sampling (see Section 2.6.3) suggests that pencil pitch releases impacted the riverbank of Slip 3 and the bank upriver of Slip 3.

Six outfalls are located along the Slip 3 riverbank. These outfalls drain areas limited to the Slip 3 Upland Facility.

2.5 Release History

Available information from regulatory agencies and Port records were reviewed for information on spills and releases. It should be noted that most regulations mandating the reporting of spills and releases did not come into effect until after 1970; therefore, there are few if any reported spills and releases from before 1970. Based on the available records, the following releases were identified.

Pencil Pitch Releases. Releases of pencil pitch occurred at Slip 3 during the years that pencil pitch was handled (1974 to 1998) due to the nature of the unloading operations. Pencil pitch is known to be located in T4 sediments. Releases of pencil pitch occurred via the following four ways:

- Losses of pencil pitch into the river or onto the vessel or pier as the Dravo clamshell bucket transferred the material from ship to unload hopper;
- Dust emissions from handling the pencil pitch at the ship, pier, rail car, or truck;
- Cleaning of the pier after the pencil pitch transfer was completed; and
- Cleaning of the vessel after the pencil pitch was unloaded.

In November 1988, the U.S. Department of Justice notified the Port that it was planning to file an action against the Port for injunctive relief and civil penalties under the federal Clean Water Act for pencil pitch releases from T4. This notice resulted in a Consent Decree which was entered into by the Port and the U.S. in 1993. The Consent Decree assumed that some level of release occurred during each unloading operation and did not represent actual observed releases. However, there is no per-release data for pencil pitch operations. One Port employee was reported to have estimated that 4 to 5 tons (8,000 to 10,000 pounds) of pencil pitch was lost to the river with each shipment; however, this is not consistent with observations made during releases. The following known releases occurred:

- In March 1986, it was reported that 300 to 500 pounds of pencil pitch had been washed into the river.

- In August 1987, it was estimated that approximately 12,150 to 16,200 pounds of pencil pitch was spilled on the dock and contained on the Dravo that needed to be cleaned up.
- In March 1988, less than 150 pounds of pencil pitch dust was deposited on the pier.
- In 1997, there was a release estimated at 200 to 1,000 pounds.

From 1978 to 1987, Port employees under Port direction conducted the fine cleaning of the pier following a pencil pitch shipment. Part of this procedure included a final washdown of the area, which included washing some pencil pitch residuals into the river. In late 1986 to early 1987, the dock drains were plugged to eliminate pencil pitch runoff to the river, but the system proved to be ineffective.

As part of its 1987 lease, Hall-Buck installed a wash water collection and treatment system. After mechanical and hand cleaning, the Dravo and the pier were washed down and the washdown water was directed to a new concrete washdown retention basin at the shore end of the pier where the Dravo was parked after use. However, numerous releases of pencil pitch were reported during the 10 years that Hall-Buck was handling the material. Documented releases of pencil pitch into the air, onto the Terminal, and/or into the river during Hall-Buck's lease include 13 incidents/notifications from June 1986 through June 1997.

UPRR Pipeline Releases. During the City of Portland's ownership of the T4 property (between 1917 and 1971), releases were reported from the UPRR pipeline.

Releases of petroleum from the UPRR pipeline and oil dock operations occurred in and around Slip 3. A leak from the pipeline was discovered in 1970 and documentation of a release from the pipeline to the river was noted as early as December 15, 1970. Oil slicks were observed in Slip 3 on March 5, 1971 and December 28, 1971. On February 2, 1972, black oil was observed to be discharging from an old drainpipe of unknown origin at the southeast corner of Slip 3. Subsequent sheens were reported in Slip 3 related to the petroleum seeps into the river from the UPRR operations. These petroleum releases and seeps to the river from the UPRR pipeline and related operations have been the subject of DEQ and EPA investigation and cleanups.

Other Releases to Surface Water. From 1971 through 2011, there were 76 reported release events at T4. Most of these events were related to sheen observed on surface water (46 events) or releases of oil in the range of 5 to 300 gallons (11 events). Six events were related to small quantities of aluminum ore or unknown materials. The remaining 13 events were release of materials not containing potential COCs (grain, soda ash, ammonium sulfate, sulfur, lignin, and tallow).

Other Upland Releases. Additional environmental releases not over water include the following:

- In 1989, following removal of an AST, stained soil was observed at the Rogers Terminal and Shipping leasehold (east of Slip 1). In 1997, Rogers removed stained soil from their leasehold.

- On September 26, 1991, a leaking drum with asphalt related material was observed in the Matson Warehouse at Pier 2, Slip 1. The Port characterized the material and properly disposed of the drum.
- In April 1992, Cargill discovered contamination in a water well northeast of Cargill Operating House Building 152 (north of Slip 1). An environmental assessment was conducted at the end of CLD Pacific Grain/Cargill's lease in 2003 and identified a variety of spills and releases associated with Cargill's operations. These releases included but were not limited to hydraulic oil releases at the Cargill pump house. Cargill subsequently contracted with Mactec to remove impacted soils in November 2003. Releases from Cargill's operations were investigated as part of the DEQ-supervised Upland Source Control evaluation of the OU1 area of the Slip 1 Upland Area. The remedial investigation was completed in 2006. Investigation revealed the presence of non-aqueous phase liquid (NAPL) at approximately 17 feet below ground surface (bgs).
- On November 23, 1992, while performing a routine monthly inspection of the sewer lift station on the Cereal Foods leasehold (north of Slip 1), a Port plumber noted a petroleum/organic odor. The sewer lift station was pressure washed and the material was staged in a 55-gallon drum. The material was sampled, and toluene and xylene were detected.
- On April 5, 1995, while performing an annual inspection of the Oregon Terminal Company leasehold, dark patches in the gravel were observed. On May 4, 1995, Oregon Terminal Company reported a release at its gearlocker of approximately 40 to 50 gallons of diesel fuel into their steam cleaner sump tank. Spencer Environmental pumped out the sump tank on May 6, 1995.
- On April 7, 1998, 10 tons of lignin foam were spilled at the International Raw Materials property (east of Slip 1). Approximately 8 tons of the material were recovered.
- In 2008, paint chips from Cargill grain tanks were observed near and in catch basins. Samples from the catch basins were collected in March 2008. PCBs were detected in the paint chips and the catch basin solids. During the RI, PCBs were also detected in surface soil collected from around the grain tanks.

In addition, although there were no recorded releases of materials that were handled during the City of Portland period of ownership and operations (prior to 1971), constituents consistent with coal, ore, and metals concentrate materials that were handled during that period have been detected in upland soil and river sediments. Lastly, impacts have been identified at the City septic systems and tanks that were historically in use at T4 Slip 1.

2.6 Previous Investigations

The following sections summarize significant previous investigations and remedial activities that have occurred at T4.

2.6.1 *Upland Investigations and Remediation*

Multiple upland investigations and remediation activities have been conducted at T4 since the 1970s. These investigations have included both soil and groundwater evaluations. Previous upland investigations and remediation activities are described below. Investigations of riverbanks are discussed in detail in Section 2.6.3.

2000 Preliminary Assessment (PA) of Terminal 4. In 2000, the Port completed a preliminary assessment of T4 at the request of DEQ (Port, 2000). The PA provided a history of the facility, discussed wastes generated, and evaluated potential exposure pathways. The preliminary assessment concluded that impacts to groundwater were not anticipated, and direct contact with hazardous substances was unlikely because there was no evidence of contamination in surface soils, subsurface soils, or groundwater. The DEQ provided comments on the PA in 2001, and an additional report was submitted in 2003 to respond the DEQ's questions and comments. In November 2002, HAI conducted a limited investigation of groundwater seeps at the east end of Slip 1 (Hahn, 2003). Groundwater seep samples were collected and analyzed for petroleum hydrocarbons, PAHs, and volatile organic compounds (VOCs). No sheen was observed, and no VOCs were detected. Diesel-range and oil-range petroleum hydrocarbons were detected at one of the three sample locations. PAHs were detected above DEQ Ecological Screening Level Values at two locations. Results were highly variable and believed to be impacted by suspended solids.

Remedial Investigation Report, Terminal 4, Slip 3 Upland. The Slip 3 RI (Hart Crowser, 2000) was designed to assess the nature, extent, and magnitude of petroleum hydrocarbons and other potential chemicals of concern at the Slip 3 Upland Facility. The Slip 3 RI incorporated the results of previous site investigations and remediation activities, including the following:

- **UPRR Terminal 4, Pier 5 Oil Recovery.** UPRR began recovery of oil at Slip 3 in response to oil seepage observed between November 16 and December 15, 1970.
- **PCB Release at the Pier 4, Berth 411 Electrical Substation.** On April 25, 1989, approximately 35 gallons of dielectric fluid containing polychlorinated biphenyls (PCBs) were released at the Pier 4, Berth 411 (Slip 3) electrical substation. A cleanup was conducted under EPA oversight and the release was fully contained (Hahn, 1989b, 1990).
- **Environmental Assessment of Marine Terminal 4.** An environmental reconnaissance of T4 was conducted in 1990 (Hart Crowser, 1991).
- **Waste Oil Tank Decommissioning.** Decommissioning activities were conducted at the Gearlocker facility in 1991.
- **Remedial Investigation, Slip 3 Oil Seep.** From 1993 to 1994, soil explorations were conducted, and monitoring wells were installed in potential oil seep source areas along the former UPRR pipeline and Quaker State/Gearlocker areas between Slip 3 and the eastern T4 boundary.

- **Slip 3 Oil Seep.** Seeps of petroleum hydrocarbons were observed in Slip 3 since 1970. During February 1993, oil absorbing booms were placed in Slip 3 to capture seepage along the bank.
- **Ambient Airborne Concentrations Monitoring of Pencil Pitch Dust.** In 1994, air monitoring was conducted to assess ambient concentrations of pencil pitch dust at Port personnel work stations and in the St. Johns neighborhood.
- **Site Characterization, Former Waste Oil UST.** Soil explorations were conducted, and samples were analyzed for halogenated solvents and petroleum hydrocarbons by Century West Engineering Corporation (Century West) in 1995.
- **1995 Port of Portland Tank Management Manual.** Century West created a Port-wide Tank Management Inventory, including T4 (Century West, 1995). A site assessment was also completed for the terminal, focused on tank status, including ownership identification, location mapping, state of activity/existence, and regulatory compliance.
- **Soil Removal Action.** During UST decommissioning activities that were conducted at the Quaker State/Gearlocker facility in 1991 and 1996, approximately 12 tons of soil containing petroleum hydrocarbons were excavated and removed from the facility for disposal or treatment.
- **Quaker State Site Investigation.** In 1997, Kennedy Jenks conducted soil sampling in the area of the former Quaker State oil canning facility to assess whether Quaker State's operations may have contributed to subsurface contamination in the vicinity of the Slip 3 oil seep.
- **Monitoring Well Pumping and Trenching.** Product was manually pumped from monitoring wells MW-1, MW-2, MW-3, MW-14 through MW-17, MW-19, and MW-20. Approximately 175 gallons of separate-phase hydrocarbons (SPH) were recovered from May through September 1997. In September 1997, a 1-foot deep trench was excavated along the eastern edge of Slip 3 and absorbent booms and pads were placed in the trench to intercept seeping SPH.
- **Site Investigation, Port of Portland Marine Terminal 4.** Subsurface explorations and sampling were conducted in the former UPRR pipeline and Quaker State/Gearlocker area at Slip 3 to further assess and confirm the findings of the Century West remedial investigation in 1997.
- **Additional Investigation.** In 1997, additional investigation was conducted and detected soil and groundwater contamination in the area of well MW-17 (located west of the former Quaker State/Gearlocker area) at Slip 3.
- **Northern Pipeline Investigation, Excavation, and Removal.** In May and June 1998, as part of the site investigation activities to determine the number and location of historical pipeline leaks, the historical northern 10-inch pipeline extending from the river to the eastern T4 boundary was removed. The pipeline spur to Former Berth 412 was cleaned and the ends were capped with steel plates.
- **Additional Investigation.** In June 1998, Hart Crowser collected soil and groundwater samples in the Hall-Buck area, north and east of the former Quaker State/Gearlocker facility, the rail fuel loading area, and on the western portion of the Slip 3 Upland Facility.

- **Interim Action Activities.** To stop the migration of petroleum hydrocarbons and groundwater to Slip 3, interim action system startup occurred on May 21, 1999. The interim action consisted of pumping soil vapor, SPH, and groundwater from wells immediately upgradient of the seep. By December 31, 1999, approximately 155,000 gallons of water containing petroleum hydrocarbons was treated and discharged.

Data from the Slip 3 RI, coupled with data from the prior investigations, was used for risk assessment and analysis and for the evaluation of remedial alternatives. The results of the RI defined the extent of subsurface SPH from the former UPRR pipeline releases in the area.

2004 Terminal 4 Early Action. Blasland, Bouck & Lee, Inc. (BBL) assembled a history of T4, which contained a discussion of area history and current uses, chronology of ownership and operations, historical operations, current operations, dredge and fill history, and adjacent property ownership and operations (BBL, 2004). This review was used in development of potential AOCs identified in the Remedial Investigation Work Plan for the Slip 1 Upland Facility RI (Hart Crowser, 2004a).

2004-2005 Terminal 4 Slip 1 Remedial Investigation. From 2004 to 2005, three phases of RI field activities were completed at T4 Slip 1 Upland Facility by URS (2004), Hart Crowser (2004b), and BBL/ACA/NF (2005, 2006). The Slip 1 RI incorporated the results of previous site investigations and remediation activities, including the following:

- **1989 Environmental Assessment and UST Removal at Rogers Terminal.** The 1989 assessment identified one unregistered 10,000-gallon gasoline UST at the east end of the former Gearlocker building. The 10,000-gallon UST was subsequently removed (Hahn, 1998a).
- **1996 Environmental Review and Soil Sampling – PM Ag Products, Inc., Slip 1.** GeoEngineers, Inc. (GeoEngineers) conducted an environmental review for the PM Ag Products leasehold in 1996 (GeoEngineers, 1996). Three recognized environmental conditions were identified and consisted of a liquid fertilizer spill, suspected asbestos-containing building materials, and a 12,000-gallon UST.
- **Diesel and Gasoline UST Decommissioning.** Decommissioning activities were conducted at the Gearlocker facility in Slip 1 in 1996 by GeoEngineers.
- **Limited Phase II Soil Sampling Report PM Ag Products, Inc., Slip 1.** In 1996, soil samples were collected from locations near Tank #16, where it had been reported that a release of nitrate fertilizer occurred 12 years prior.
- **Terminal 4 Track 401 Soil Sampling Project.** In 2001, URS conducted limited sampling of the railroad alignment near the International Raw Materials (IRM) Leasehold area at Slip 1 (URS, 2001).
- **2003 Environmental Site Assessment of CLD Pacific Grain/Cargill Facility.** ATC Associates, Inc. (ATC) conducted an environmental site assessment (ESA) on behalf of Cargill for the Cargill leasehold (Slip 1) in 2003 (ATC, 2003).

Results of the RI showed, with the exception of a few localized areas and along the riverbanks, contaminants of interest (COIs) were detected intermittently in soil at generally low concentrations. In addition to the localized areas, two areas of erodible riverbank soil were observed and investigated at Wheeler Bay and the southwest side of Slip 1 (see further discussion in Section 2.6.3).

No groundwater plumes were identified at T4 Slip 1 during the RI. Intermittent detections of PAHs, pesticides, and metals were observed during the quarterly monitoring program. Often, a COI was detected during only one of the four quarters of sampling, suggesting that variability in sample turbidity was the reason for the detection and was not indicative of dissolved-phase COIs.

Former Quaker State Farm Soil Characterization. In 2005, soil characterization was conducted at the former Quaker State tank farm within the T4 Slip 3 upland area. Samples were collected and analyzed for PAHs to obtain delineation.

LNAPL Removal, Groundwater Monitoring, and Contingency Plan, Terminal 4, Slip 3 Upland Facility. Light Non-Aqueous Phase Liquid (LNAPL) originated from a release from the former UPRR pipeline. LNAPL recovery has been ongoing since the 1970s and groundwater monitoring has been undertaken since the 1990s; however, since 2005 both have been conducted pursuant to a Consent Judgement (No. 0410-10234) between the DEQ and the Port. Approximately 1,470 gallons of product have been recovered from monitoring wells and passive skimmers between 2005 to present.

2011 Slip 1 Upland Facility Feasibility Study. Following the Slip 1 RI, four AOCs were retained that contained COIs at concentrations exceeding risk screening criteria: AOCs 9, 15, 29, and 83 and the Soil Stockpile Area, located adjacent north of the former Rogers Terminal. Based on the evaluation of remedial action alternatives, the highest ranking protective alternative was determined to be the Institutional Controls/Redevelopment alternative. This alternative was determined to be protective, easy to implement, and cost-effective. Additionally, based on the updated risk assessment for T4, the overall risk to human health from additive exposure to multiple PAHs in OU1 was estimated to be approximately $6x10^{-6}$ for the occupational worker exposure pathway. Implementation of the selected remedy would reduce the risk to $8x10^{-7}$. To fulfill the requirement for a soil management plan, an Interim Contaminated Media Management Plan (CMMP) was prepared and approved by DEQ (Apex, 2019). Because a final Record of Decision has not been published for T4, this CMMP is considered an interim remedial measure. The CMMP will be updated when needed as remediation or source control actions are completed.

Remedial Investigations at Slip 1 and Slip 3 and the Upland Slip 1 Feasibility Study incorporated results from several preceding investigations. Soil investigations identified elevated concentrations of PAHs in limited areas of Slip 1, to include shallow soil in the western portion, shallow soils beneath soil stockpiles, and deeper soil in the four former cesspools located in the northern central portion of Slip 1. Elevated TPH concentrations in soil were identified in deeper soil in the four former cesspools in Slip 1. TPH in soils were identified beneath the former northern pipeline south and east of Slip 3. No groundwater plumes were identified in Slip 1 Upland Facility. Petroleum LNAPL is present in the subsurface region east of Slip 3, associated with the former northern pipeline. TPH and PAH impacts to groundwater were also identified south and east of Slip 3.

2.6.2 Sediment Investigations

Multiple sediment investigations have been conducted at T4 since 1997. These investigations have included both surface and subsurface sediment, defined in the ROD as 0 to 30 cm bml and depths greater than 30 cm bml, respectively. Existing sediment investigations are described below. The majority of sediment investigation data are from the PHSS FS database (EPA, 2016) and from more recent sediment samples collected during the PDI (Anchor, 2019b) and the Pre-RD Group investigation (AECOM and Geosyntec, 2019). The PHSS FS database includes data from several previous investigations. These investigations and others are summarized below.

2015 Berth 401 Maintenance Dredging. Two post-maintenance dredging surface sediment samples were collected from Slip 1 Berth 401 (Hart Crowser, 2015). Samples were analyzed for total PAHs, PCB aroclors, total DDx, and total cPAH/BaP Eq TEQ in accordance with the EPA regional dredging guidance. Sample results were non-detect or below applicable RALs.

Berth 410 Pre and Post Maintenance Dredging. Three pre-maintenance dredging sediment samples (from 0 to 60 cm bml) were collected from Slip 3 Berth 410 in 2016. Samples were analyzed for total PAHs, PCB aroclors, total DDx, total cPAH/BaP Eq TEQ, and dioxins/furans. In 2017, three post-maintenance dredging samples were collected from the top 30 cm of the dredged area (Hart Crowser, 2017 and 2018). Samples were analyzed for total PAHs, PCB aroclors, total DDx, and total cPAH/BaP Eq TEQ. Sample results for both pre- and post-maintenance were non-detect or below applicable RALs.

2016 PHSS FS. The PHSS FS database includes data from several previous investigations, ranging in date from 1997 to 2008. A total of 182 surface and subsurface sediment samples from the T4 site were evaluated in the FS.

Surface sediment data contained elevated concentrations (above RALs) of PAHs and PCBs. PAH exceedances were generally located in Slip 3 near the former pencil pitch offloading area (Pier 4). Elevated PAH levels were also observed in the southeast corner of Wheeler Bay and parts of Slip 1. Sample concentrations that exceeded the RAL for PCBs were generally low-level exceedances of less than two times the RAL. Most exceedances were observed in Slip 1, including the area beneath Pier 2, and in the Slip 3 navigation channel and under the former Pier 5 structure. One sample, located near the southwest end of Slip 1 (collected in 2004), also exceeded the principal threat waste (PTW) highly toxic threshold for PCBs (200 µg/kg). No exceedances were detected for DDx or dioxins/furans.

Subsurface sediment data contained elevated concentrations (above RALs) of PAHs, PCBs, and DDx. PAH exceedances were generally located in Slip 3 within the top 1.5 meters (m) bml. Few exceedances were located in Wheeler Bay and only one sample from Slip 1 exceeded the RAL for PAHs. A majority of the core locations with RAL exceedances of PAHs were bounded by at least one deeper sample that was below the RAL; a few unbounded locations were subsequently re-occupied and bounded during the 2019 Pre-Remedial Design Investigation. PCB exceedances were generally located in Slip 3 within the top 1.5 meters bml. Elevated PCBs were detected in Wheeler Bay down to 5 meters bml. PCB exceedances in Slip 3 were located near the head and typically co-located with PAH exceedances. DDx was only detected at elevated concentrations in two samples, located just south of Slip 3 and one sample near the head of Slip 3 (co-located with higher PCB and PAH concentrations). All deeper samples at these locations contained DDx concentrations below the RAL.

Nearly all of the surface sediment data in the FS database is over 10 years old and may no longer be representative of current conditions due to sediment deposition and erosion, mixing and dispersion, and/or natural recovery processes.

2018 Pre-Remedial Design Group (Pre-RD Group). Surface and subsurface data were collected in 2018 throughout the T4 SDU. The sampling event consisted of 24 surface sediment locations and two subsurface sediment core locations. In surface sediment data, one sample exceeded the RAL for total PAHs in Slip 3; six samples exceeded the RAL for PeCDD in Slip 1; and five samples exceeded the RAL for TCDD in Slip 1. Other analyzed constituents (PCBs, DDx, and PeCDF) were not detected at concentrations that exceed the respective RALs.

The two subsurface cores were collected from Wheeler Bay and the southeast corner of Slip 3. PCBs, DDx, and PeCDF RALs were not exceeded in any of the analyzed core intervals. The core collected from Wheeler Bay had total PAHs exceedances from the 0- to 2-foot and 2- to 4-foot sample intervals. Deeper sample intervals were below RALs for total PAHs. TCDD and PeCDD concentrations exceeded the RALs in the 2- to 4-, 4- to 6-, and 6- to 8-foot sample depth intervals. No samples were collected deeper than 8 feet. The core located at the southeast corner of Slip 3 contained total PAH concentrations and total PeCDD concentrations above the RALs in the 3- to 4.5-foot sample depth interval. Deeper sample intervals from this core location were below RALs for total PAHs and PeCDD.

2019 Pre-Remedial Design Investigation. This investigation conducted in 2019 included the collection of surface and subsurface sediment samples from the open-water and underpier areas. A total of 62 surface sediment samples and 24 subsurface sediment cores (which generally contain more than one sample per core) were analyzed as part of this investigation. Figures displaying the sample locations and summarized analytical results from the Pre-Remedial Design Investigation are included in Appendix A for reference.

Less than 20 percent of the PDI surface sediment sample locations have concentrations that exceed the RAL for one or more harbor-wide COCs. In general, total PAH exceedances were located in the underpier area of Slip 3 and in the middle of Slip 3. Total PCB exceedances were detected in three samples, with isolated PTW exceedances in the underpier areas of Slip 1 and Slip 3 and one RAL exceedance at the head of Slip 1. Four samples in Slip 1 and one sample in Slip 3 also exceeded the RAL for the dioxin PeCDD.

Subsurface sediment data exceeded the RAL in one or more sample for PAHs, PCBs, and DDx. Total PAH exceedances were generally located in Slip 3 near and under Pier 4 (the former pencil pitch offloading area). A few PAH exceedances were also observed at Berth 414 and Wheeler Bay. Total PCBs exceeded the RALs in two samples from Slip 3. Dioxins/furans, specifically PeCDD and TCDD, were identified in eleven samples at concentrations exceeding RALs, collected from six locations in Slip 1, Slip 3, and Wheeler Bay.

For a detailed description of the nature and extent of COCs in the T44 surface sediment, please refer to the following associated reports: *PDI Work Plan* (Anchor, 2019a) and *Draft Pre-Remedial Design Investigation Summary Report* (Anchor, 2019b).

2.6.3 Riverbank Sampling and Source Control Activities

This section summarizes sampling and source control actions that have been conducted on the T4 riverbanks. Historical riverbank data are listed in tables in Appendix B. Sample location areas are shown on Figure 2 and detailed sample location figures are included in Appendix B.

Bank Excavation and Backfill Remedial Action (BEBRA). Petroleum seeps, sheen on surface water, and groundwater with petroleum discharging to Slip 3 were associated with historical LNAPL seepage and were addressed in 2004 with the BEBRA activities. This action was conducted at the head of Slip 3 as shown on Figure 2. This action also removed surface soil and riverbank soil and stabilized the riverbank. A total of 4,581 tons of impacted soil were removed during the activities. Following the excavation activities, the area was backfilled to pre-excavation grades with sand fill, borrow, and riprap, and the surface was finished with native vegetation. The sand fill was amended with organoclay designed to adsorb petroleum hydrocarbons prior to the groundwater entering the river (ACA/BBL/NF, 2005).

Pencil Pitch – South Bank Characterization, Slip 3. Two phases of investigations were conducted to assess pencil pitch in riverbank soils on the south bank of Slip 3 and the riverbank south of Slip 3. The results of these investigation showed that PAHs are present in surface soil on the south slip bank area at elevated concentrations (ACA/Newfield, 2007; ACA, 2008).

Slip Bank Source Area Removal. A source control alternatives evaluation was conducted, and removal was selected as the source control measure. In October 2009, the Slip Bank source area located at the northeast corner of the head of Slip 3, was excavated, restored to original grade, and potential erosion was addressed with gravel fill on the Slip Bank and topsoil/plants/mulch in the upland area (ACA, 2010). Based on the completed riverbank stabilization actions, the riverbank erosion source at the Slip Bank has been controlled.

Wheeler Bay Bank Sampling. As part of the Slip 1 RI, eight riverbank soil samples were collected from erodible areas on Wheeler Bay and the south side of Slip 1. The samples were analyzed for PAHs, phthalates, PCBs, pesticides, and metals. PAHs, pesticides, and metals were detected above screening levels. PCBs were not detected at Aroclor detection limits ranging from 34 to 84 µg/kg. PAH exceedances above applicable screening levels were observed in each analyzed sample for at least one PAH analyte, including benzo(a)pyrene, benzo(b)fluoranthene, benzo(a)anthracene, indeno(1,2,3-cd)pyrene, and dibenz(a,h)anthracene. One sample contained concentrations of 4,4'-DDT above screening levels. Seven samples contained at least one metal (arsenic, cadmium, copper, lead, zinc, silver, and mercury) at concentrations above applicable screening levels and background levels.

Wheeler Bay Bank Stabilization. Wheeler Bay bank stabilization was conducted as a source control measure during the 2008 T4 Phase 1 Removal Action (Ash Creek Associates [ACA], 2009). Shoreline stabilization activities included regrading to reduce the overall slope of the shoreline, placement of large woody debris and rip rap to resist erosive forces, and placement of habitat material over the riprap and cover soil/plants to enhance in-water and upland habitat (as indicated on Figure 6). Additional construction activities to repair erosion that exposed potentially contaminated material in the planted area occurred in 2010, 2011, and 2019. Wheeler Bay is currently monitored via the approved Amendment to the 2008 Interim Monitoring and Reporting Plan (Anchor, 2020) to evaluate the effectiveness of stabilization activities and to identify any potential erosion or contamination issues that may arise. As a result of the bank stabilization activities and ongoing monitoring, Wheeler Bay is not considered a potential source of recontamination of river sediments and is not discussed further in this Work Plan.

3.0 Conceptual Site Model

This section summarizes the CSM including site geology and hydrogeology, nature and extent of contamination, and development of Site COIs at T4.

3.1 Geology and Hydrogeology

A detailed description of the geology and hydrogeology of T4 is presented in the *Characterization Report, Terminal 4 Early Action* (BBL, 2004) and is reaffirmed and/or refined in *Terminal 4 Slip 1 Remedial Investigation Report* (ACA, 2007), and the *PDI Work Plan* (Anchor, 2019a). Based on these reports, the T4 geology and hydrogeology are summarized in the following sections.

3.1.1 T4 Geology

The geology beneath T4 consists of the following generalized units:

- **Upland Fill Material** – Medium to fine sand; unit ranges in thickness from approximately five to 40 feet. Fill material generally increases in thickness towards the river.
- **Modern Sedimentary Deposits** – Silt, sandy silt, and silty sand; historical accumulations of approximately one to five feet thick, thickness increases towards the interior of the slips.
- **Unconsolidated Alluvial Deposits** – Fine sand located west of the former shoreline and interbedded layers of gravel, sand, silt, and clay to the east of the former shoreline; deposits range from approximately 65 to 160 feet thick.
- **Troutdale Formation** – Gravel and sandy gravel; the formation is generally encountered at an elevation of approximately -114 to -168 feet CRD (Columbia River Datum). Total thickness of the Troutdale formation is estimated to be about 100 feet thick.

3.1.2 T4 Hydrogeology

The regional groundwater flow direction at T4 is west towards the Willamette River. Nearshore, groundwater flow in the fill and unconsolidated alluvial deposits are in direct hydraulic connection with the river; thus, groundwater elevations fluctuate in response to the river stage. Depth to groundwater in the upland monitoring wells at Slip 3 during recent monitoring events showed a range of approximately 6.5 to 31 feet below ground surface (bgs).

Groundwater seeps have been historically observed mainly at the east ends (interiors) of Slip 1 and Slip 3. Because groundwater flow is toward the river and predominately within the fill unit, groundwater seeps occur when the river stage is at an elevation below the contact of the fill unit and alluvial unit. However, the geologic contact between the units is typically below the river stage.

3.2 Nature and Extent of Contamination

3.2.1 Riverbank Soil

A total of 54 soil samples have been collected from the T4 Slip 1 and Slip 3 riverbanks. Samples were collected as part of pencil pitch investigations and the Slip 1 Upland Facility RI. These investigations were focused on the southwest side of Slip 1 (i.e. west of former Berth 408), Wheeler Bay, the south side of Slip 3 (former Pier 5), and the riverbank south of Slip 3. General sampling locations are shown on Figure B-1 in Appendix B. Historical riverbank soil data are also provided in Appendix B. The historical riverbank soil data are more than ten years old. These data may no longer be representative of current soil conditions because of changing conditions such as erosion or deposition, decomposition, weathering, or other processes. Historical results are summarized as follows.

- **PAHs.** Forty-eight riverbank soil samples were analyzed for PAHs. PAH concentrations were detected above the laboratory reporting limits for at least one PAH constituent in each sample. Eleven samples exceeded the CUL for total PAHs (seven samples from Slip 1 and four from Slip 3) and ten samples exceeded the RAL for total PAHs. Forty-four samples contained benzo(a)pyrene toxic equivalents (BaP Eq) above the CUL. Elevated PAHs were observed in samples collected from each investigation area with no observed spatial trend.
- **PCBs.** Eight riverbank soil samples have been analyzed for PCBs. The samples were composite samples collected from the southern side of Slip 1 and Wheeler Bay. None of the analyzed samples were detected above laboratory reporting limits. However, laboratory reporting limits were greater than the CUL for total PCBs, but below the RAL for total PCBs (with the exception of one sample with a reporting limit above the CUL and RAL for total PCBs).
- **Pesticides.** Forty riverbank soil samples were analyzed for pesticides to include both composite and discrete samples collected from the southern side of Slip 1 and Wheeler Bay. None of the analyzed samples were detected at concentrations above RALs. Six samples contained DDx above CULs. Four samples contained dieldrin above CULs.
- **TPH.** Fourteen samples were analyzed for TPH diesel and oil, located in Slip 3. Five of the samples were detected above laboratory reporting limits for diesel and nine were detected for oil. Three samples exceeded the CUL for TPH diesel.
- **Metals.** Twenty-one riverbank soil samples were analyzed for metals to include both composite and discrete samples collected from the southern side of Slip 1 and Wheeler Bay. Arsenic, cadmium, lead, mercury, and zinc were detected above CULs at least once. No spatial patterns were identified.

3.2.2 Surface Sediment

More than 100 surface sediment samples have been collected at the T4 SDU throughout the past 20 years. In 2019, Anchor QEA conducted a comprehensive surface sediment investigation as part of the Pre-Remedial Design Investigation, supplemented by data collected in 2018 by the Pre-RD Group. For a detailed description of the nature and extent of COCs in the T4 surface sediment, please refer to the following associated reports: *PDI Work Plan* (Anchor QEA, 2019a) and *Draft Pre-Remedial Design Investigation Summary Report* (Anchor QEA, 2019b). The findings from these reports are also summarized in Section 2.6.2 of this Work Plan.

3.2.3 Data Gaps

The following is a summary of data gaps for riverbank soil characterization at T4.

- **Sample Quantity.** Previous riverbank soil samples have focused on targeted areas of the T4 riverbank (southwest side of Slip 1; Wheeler Bay; south side of Slip 3; and between the mouth of

Slip 3 and Berth 414) using historical activities and features that may be areas of concern as contaminant sources. No data is available for the remainder of the riverbank.

- **Analyzed Contaminants.** Many riverbank soil samples were analyzed for a targeted list of analytes. No samples have been analyzed for dioxin/furans, and only eight samples were analyzed for PCBs.
- **Age of Existing Data.** The existing riverbank soil data were collected between 2005 to 2007, with the exception of several samples collected at Wheeler Bay between 2010 and 2018. This data may no longer be representative due to changing conditions along the riverbank.

3.3 Chemicals of Interest in Soil

COIs were developed for the T4 riverbank by evaluating historical potential sources of contamination, release history, and previous riverbank and sediment investigations. Based on this evaluation, the COIs for riverbank soil include TPH-d, PAHs, PCBs, pesticides, dioxins/furans, and metals (arsenic, cadmium, copper, lead, mercury, and zinc).

The riverbank was separated into regions based on consistent historical operations/material handling or other potential sources with comparable COIs. The identified areas and associated COIs are described below and summarized in Table 1. These identified COIs, together with other factors such as providing a range of coverage for all COIs, were used to assign chemical analyses to the collected riverbank samples.

There are documented releases of petroleum hydrocarbons within each area of the facility, therefore TPH-d is a chemical of interest in every area of the facility, and not described in each area individually below.

Berth 401. No COIs were detected above RALs at Berth 401; however, PCBs and dioxins/furans were detected above RALs in sediment samples from adjacent areas. Therefore, COIs for Berth 401 riverbank soil include TPH-d, PCBs, and dioxins/furans.

North Side Slip 1. Previous sediment investigations identified dioxins/furans above RALs in the vicinity of this area. COIs for the north side of Slip 1 include TPH-d and dioxins/furans.

Berth 405. Previous sediment sampling results identified dioxins/furans and PCBs above RALs in sediment. COIs for Berth 405 include TPH-d, PCBs, and dioxins/furans.

Berth 409. Previous sediment sampling identified PAHs, PCBs, and dioxin/furans with concentrations above RALs in sediments adjacent to the berth. COIs for Berth 409 include TPH-d, PCBs, PAHs, and dioxin/furans.

Berth 408. Historical operations at this Berth included ore handling and releases of ore and diesel were identified during the historical review. Additionally, PCBs and dioxin/furans were detected above RALs in sediment samples near the Berth. COIs for Berth 408 include TPH-d, metals, PAHs, PCBs, and dioxin/furans.

South Side of Slip 1. Historical operations included the handling of ore material. Previous sampling of the sediment identified dioxin/furans above applicable RALs. Previous soil sampling identified PAHs, metals, and pesticides in riverbank soils above CULs and JSCS SLVs. Additionally, PCBs were detected above the PTW in a surface sediment sample adjacent to this portion of the riverbank. COIs for the south side of Slip 1 include TPH-d, metals, PAHs, PCBs, pesticides, and dioxin/furans.

Riverside of Slip 1. There is no sediment data adjacent to this area with concentrations above RALs and no previous soil sampling. Therefore, the COI for this area is TPH-d based on historical releases of petroleum.

Berth 411. Pencil pitch (containing PAHs) was historically handled and released at this berth. A release of fluids from a transformer occurred in this vicinity (fluids were contained within the vault). Ore handling occurred nearby. Additionally, sediment sampling has detected PAHs and PCBs above RALs. COIs identified for this berth include metals, PAHs, PCBs, and TPH-d.

Head of Slip 3. Sediment sampling identified PAHs and PCBs above RALs in the vicinity of this area. This area is near historical pencil pitch handling and soil sampling has detected PAHs above CULs. Petroleum pipeline releases occurred in this area. COIs for the Head of Slip 3 are TPH-d, PAHs, and PCBs.

Berth 412/Former Pier 5. Ore material was historically handled at this Berth. Petroleum pipeline releases occurred in this area. In addition, soil sampling has detected PAHs and previous sediment sampling nearby identified sediment with concentrations of PAHs and dioxin/furans above RALs. However, only one sediment sample in the vicinity of Berth 412/former Pier 5 slightly exceeded RALs for dioxin/furans, therefore dioxins/furans are not considered COI at Berth 412. The COIs for Berth 412/former Pier 5 include TPH-d, metals, and PAHs.

Riverside of Slip 3. Sediment sampling has identified PAHs above RALs in this area. COIs for the riverside of Slip 3 are TPH-d and PAHs.

3.4 Chemicals of Interest in Sediment

The COIs for sediment based on those defined in the PDI Work Plan, consistent with the harbor-wide focused COCs presented in the ROD:

- PAHs;
- PCBs; and
- Dioxins/furans.

Although DDx is listed as a harbor-wide focused COC in the ROD, historical sediment sampling in the T4 SDU have resulted in few exceedances that were not replicated with additional sampling. The PDI Work Plan selected a few samples for DDx analysis based on historical detections. The PDI Work Plan did not include DDx analysis for the proposed sediment sample locations included in this Work Plan.

4.0 Chemical Characterization of Riverbank

4.1 Sample Locations and Numbering

This section describes the development of the proposed sample locations. Sample locations were selected using both probabilistic-based and judgmental sampling design. These two methods were selected based on the EPA's Guidance on Choosing a Sampling Design for Environmental Data Collection (2002). These sampling methods were selected as the most appropriate approaches to delineate areas where contaminant concentrations exceed screening levels as defined in the ROD.

4.1.1 Judgmental Soil Sample Locations

Judgmental sampling design involves the selection of sample locations based on knowledge of site conditions and professional judgement (EPA, 2002a). Judgmental samples are most applicable to characterizing relatively small potential source areas (i.e., "point sources") where the extent of contamination is relatively limited. Knowledge of the site was combined with results of the riverbank reconnaissance to select judgmental sample locations as presented on Figure 4. Fifteen judgmental sample locations were selected. Fourteen samples are located below the outfalls located at the Site and one sample is located at an area identified during the riverbank reconnaissance with observed erosion (near the Head of Slip 3). These were the only identified potential point sources at T4. Larger scale potential source areas are addressed with probabilistic sampling as described in the next section.

4.1.2 Probabilistic Soil Sample Locations

In general, with few exceptions (i.e., the outfalls and the small erosion area at the Head of Slip 3 discussed in Section 4.1.1), the potential contamination sources were identified by proximity to historical material handling, material storage, or releases areas to riverbanks. The potential impacts to riverbanks, if any, would be expected to cover relatively large areas, spanning several hundred feet or more. The general use of a probabilistic approach allows for statistical inferences to be made about the sampled population, a reasonable method to characterize the large area of riverbank. Probabilistic-based sampling design involves random selection of sampling locations (EPA, 2002a). To ensure adequate coverage of the T4 riverbank, a modified random sample approach was used.

The total length of the Slip 1 and Slip 3 Upland Facilities riverbank is 7,700 lineal feet. As described in Section 5.1.2, Wheeler Bay, Berth 411, and the Head of Slip 3 are fully armored or have completed source control actions. These areas, totaling 2,000 lineal feet, will not be sampled using probabilistic-based sampling. Therefore, a total of 5,700 lineal feet of riverbank are targeted for probabilistic sampling.

Sample locations were determined by establishing a grid on the targeted riverbank and assigning one sample location within each cell of the grid. The grid was established by dividing the riverbank into 150-lineal-foot sections. One-hundred-fifty-foot spacing was selected for consistency with the EPA-approved PDI sampling approach at T4 (originally based on recommendations in EPA's 2017 DRAFT Portland Harbor Superfund Site: Sampling Plan for Pre-Remedial Design, Baseline, and Long-Term Monitoring [EPA, 2017b]). The lineal sections were measured along the center line between top of bank (TOB) and -2 CRD. Each 150-foot section was further divided into an upper and lower sampling area. A total riverbank length of 5,700 lineal feet results in 76 sampling units (2 units per 150 lineal feet) – see Figure 4.

The sample location was randomly selected within each unit as follows. Unit 01 Upper and Lower were each divided into 50 approximately equal-sized cells. One of the cells in each of the upper and lower units was selected for sampling using a random number generator (Cell 16 in upper and Cell 65 in lower). The same cells in each of the subsequent units were selected for sampling, resulting in systematic coverage of the upper and lower units with randomized starting positions. Figure 5 is a schematic plan showing the sample locations. A probabilistic sample will be collected for archive from cells containing a judgmental sample. The archived sample will be analyzed if any of the associated judgmental sample concentrations exceed RAL or PTW thresholds.

Table 2 lists the coordinates for the proposed sample locations including the sample numbering scheme that will be used. Samples will be collected at these locations unless one of the following conditions occurs:

- For judgmental samples, the proposed locations are approximate. The actual sample location will be moved as needed to correspond to the targeted feature (stormwater outfall, observed erosion feature, etc.).
- For probabilistic samples, locations that fall within an area of hardscape or heavy armor preventing collection of a soil sample will be moved (see Section 4.2 for sample adjustment protocols).
- The sample location is under water (see Section 4.2 for more information).

4.1.3 Sediment Sample Locations

During PDI sediment sampling in 2019, the sample vessel was unable to access the target locations of four surface sediment sampling points at former Pier 5 due to the presence of dense underwater pilings (Anchor, 2019b). Three of the locations were moved toward the center of Slip 1 and one location (SG07) was abandoned following EPA approval. Sediment samples will be collected at these four PDI locations at former Pier 5 as shown on Figure 4 using the target locations from the PDI Work Plan (Anchor, 2019a). Sampling will be attempted from the riverbank during favorable river stage conditions. However, this area has not been previously sampled and access routes or methods to these locations may be amended based on the site conditions and safety considerations.

4.2 Sampling Methodology

Riverbank soil will be collected by using a shovel or hand auger to a dig to a depth of 30 cm bgs. The soil sample will then be collected from freshly exposed soil on the sidewall of the excavation from 0 to 30 cm bgs using a clean stainless steel spoon. The soil will be placed directly into a stainless steel bowl and homogenized. Samples intended for analysis of volatile organic compounds (see Section 4.3) will be collected using EPA Method 5035. A detailed description of the sampling methodology and standard operating procedures are included in the Sampling and Analysis Plan (SAP) presented in Appendix C.

Sediment samples will be collected using a side filling chambered-type discrete-point sampler. Each sample will consist of a 3-point composite spaced in a triangular pattern and collected from 0 to 30 cm bml. A detailed description of the sampling methodology and processing is presented in the SAP (Appendix C).

Due to the potential presence of hard substrates or buried riprap beneath proposed sample locations, a minimum soil or sediment recovery thickness of 10 cm will be acceptable. If the recovery is less than 10 cm, the sample location will be adjusted by moving the sample point two feet to the right (facing directly upslope). If sample collection at the new point is not feasible, the point will be moved two feet upwards from the original location (towards the uplands). If a soil sample has not been recovered, the sample location will continue to be adjusted in a counterclockwise pattern centered around the original sample point (two feet to the left, then two feet downwards towards the river). If a suitable sample location still is not identified, the pattern will continue, stepping out an additional two feet with each circuit, until an acceptable sample is collected or no acceptable sample location is identified in the unit cell. In the event that a suitable location is not identified within the unit cell, that sample will not be collected. Any sampling locations requiring adjustments will adhere to this protocol and field documentation will be provided for samples that were not collected at the proposed locations.

Based on the proposed schedule to sample during low water conditions, it is unlikely to encounter proposed sample locations under water during field activities; riverbank sample locations are anticipated to be exposed during normal seasonal low water conditions. In the event that sampling locations are under water at the time of the field event, the lower bank sampling would be deferred until low water conditions are present.

Substantive changes in the scope of work or modifications required based on field conditions (including the inability to recover a soil sample within a unit cell) will be documented on the Field Change Request Form and promptly submitted to EPA for approval (see Appendix C for more information). Rapid approval turn-around times from the EPA on Field Change Requests are crucial to maintain the field schedule. This Work Plan assumes the EPA project manager and a designated alternative contact will be readily available during the field work hours to expedite the approval protocols.

A site-specific health and safety plan will be prepared prior to conducting field activities. The health and safety plan will be submitted under separate cover at least four weeks prior to the fieldwork commencement date.

4.3 Analytical Testing Program

Soil samples collected from each riverbank area will be analyzed for the COI identified as a concern in that area as discussed in Section 3.3 and summarized in Table 1. A subset of samples representing at least 20 percent of the total samples collected will be analyzed for the full suite of COI as defined by COI listed in Table 17 of the PHSS ROD and consistent with Table 1 of the EPA Guidance for River Bank Characterization and Evaluations (EPA, 2019). Table C-1 lists the analysis to be conducted for each riverbank sample.

The four sediment samples will be analyzed for the COI listed in Section 3.4, consistent with Table 21 of the PHSS ROD. Table C-3 lists the analysis to be conducted for each sediment sample.

5.0 Physical Characterization of Riverbank

The physical and material characterization of the riverbank will be evaluated to determine the stability and the potential for soil to erode into the river. The physical/material characterization of the riverbank will include a site reconnaissance, collection of existing site information, and an erodibility evaluation.

5.1 Site Reconnaissance

On March 12 and May 20, 2019, Apex personnel conducted a reconnaissance of the T4 riverbank to provide information on the condition of the riverbank. There are varying types of armor and erosion control structures along the T4 riverbank. Figure 6 summarizes the results of the reconnaissance. Appendix D presents representative photographs of the riverbank. Observed riverbank conditions were grouped into categories exhibiting similar characteristics in amount and type of surface protection (i.e. armor, vegetation) and presence of erosional features. Descriptions of the categories observed during the reconnaissance are presented below. An updated site reconnaissance will be completed concurrent with the field activities associated with the chemical characterization portion of the Work Plan. The updated riverbank reconnaissance will include more detailed information regarding the surface conditions, areas of erosions, and photographs for each sample cell.

5.1.1 Observed Erosional Areas

Mix of Vegetation and Armor – Areas of Erosion Observed. These areas consist of a mix of vegetation and armor. The armoring is generally on the lower bank and vegetation on the upper, but there are areas of vegetation within the armoring. The overall bank appears stable but there are areas of observed erosion scattered throughout. Observed erosion covers much less than half of the total area. The bank areas falling within this category include:

- North end of the riverbank at Berth 401 – This section has dense vegetation on the upper section with gravel below. Erosion scarps observed above beach (see Photos 1 and 2 in Appendix D).

- Small section at the Head of Slip 3 – A small area of erodible soil was observed during the reconnaissance around a recently installed sign (Photo 3).
- Riverside of Slip 3 – The riverbank in this section has a concrete retaining wall at the top of bank. Below the retaining wall is a mix of rip rap and vegetation. In some areas, there is a gap of several feet between the base of the retaining wall and the start of the rip rap. Erodible soil was observed in the gap area (Photo 4).

Wooden Retaining Wall – Wall Failure and Erosion Observed. Riverbanks beneath piers were historically stabilized with wooden retaining walls supported by concrete columns. Multiple walls, each about 3 to 4 feet in height stepped down the riverbank. In some areas, gravel was placed on the soil surface between the walls. Where the walls are still present, the bank is stable, and no erosion is observed. In many areas, the wooden members of the walls have rotted and failed, leading to erosion. Bank areas with wooden walls are located as follows.

- South end of Berth 401 – The south end of Berth 401 has a concrete retaining wall at the top of bank. A wooden retaining wall with concrete posts is present below the concrete retaining wall. Sections of the wood retaining wall have failed, and erodible soil was observed in these areas (Photo 5).
- North side of Slip 1 – Dense vegetation is present on the upper section of the North Side of Slip 1 behind the wooden retaining walls. On the lower section of the North Side of Slip 1, approximately one-fourth of the wooden retaining walls have failed. Erosion was observed wherever there was a wall failure. Some of the failed wall areas have been stabilized with rip rap (Photos 6 and 7).
- Berths 405 and 408 – The presence of the berths limited the ability to view the underlying riverbank. Direct observation could only be made under the berths on the west ends, towards the river, where visible light could penetrate under the dock structure. Based on the visible areas under the berths, there appears to be a similar failure rate for the wooden retaining walls in these sections (Photos 8 and 9). There is significant uncertainty in this conclusion on failure rate. For example, areas that could not be observed are better protected from weathering so may have a lower failure rate.
- Berth 412/former Pier 5 – The majority of the walls have failed in this area and there is ongoing erosion. In areas that have not failed, there is dense vegetation. This vegetation does not appear to fully prevent further erosion based on observations of undermining following wall failure that undercuts the vegetation (Photos 10 and 11).

Vegetation and Soil. The South Side of Slip 1 has native trees/shrubs along the top of bank planted as part of landscaping work as evidenced by temporary irrigation. There was no indication of armoring on the riverbank. Most of this riverbank shows visible signs of erosion (Photos 12 and 13).

5.1.2 No Observed Erosion

Mix of Vegetation and Armor – No Erosion Observed. On either end of the concrete low dock located at Berth 409, the riverbank is densely vegetated with trees and shrubs. No erodible soil was observed within this vegetation.

Fully Stabilized (Hardscape/Rip Rap/Riverbank Stabilization Complete). The riverbank is fully stabilized in areas where it is completely covered with a structural bulkhead or rip rap, or where source control stabilization measures have been completed. Bank areas that are fully stabilized are located as follows.

- Berth 409 – Berth 409 is a concrete dock (Photo 14).
- Riverside of Slip 1 – This area consists of rip rap armor on the lower slope and established vegetation on the upper slope (Photo 15).
- Wheeler Bay – Riverbank stabilization was completed in Wheeler Bay in 2008 using a combination of rip rap covered with habitat material and large woody debris on the lower slope and vegetation on the upper slope (Photo 16).
- Berth 411 – The Berth 411 riverbank beneath the pier is stabilized with rip rap (except for one small area that appears to have soil on top of rip rap; Photo 17).
- Head of Slip 3 – The interim action to address the oil seep included excavation of riverbank soil and restoration with clean soil, rip rap on the lower slope, and vegetation on the upper slope (Photo 18).

5.2 Evaluation of Existing Site Information

An evaluation of existing site information will be performed to aid in the identification of representative sections of the riverbank and its characteristics. Existing site information will include (if available) a review of previous site reconnaissance, site plans, topographic maps, aerial photographs, lidar maps, geologic maps, soil survey information in the vicinity of the Site, previous investigation data, boring logs, well logs, geotechnical reports, and bathymetry maps for the Willamette River.

In addition, a high-resolution topographic survey of the Site riverbank will be performed to support riverbank stability evaluations and creating profile sections. The topographic survey will cover an area of 21 acres with anticipated vertical accuracy of 1 foot.

Riverbank physical and material characteristics to be assessed will include the following.

- **Height of Bank and Bankfull Level.** Riverbank height, from the top of the bank to the toe of the slope, will be determined from topographic and bathymetric maps. Bankfull level is defined as the point on the riverbank that contains normal non-flood level flows of the river throughout the year and is characterized by visible changes in topography, vegetation type, or sediment grain size. For the Willamette River, the bankfull level is approximated at the OHW elevation.

- **Bank Angle.** The bank angle (also referred to as the riverbank slope) will be calculated from topographic maps.
- **Riverbank Soil Types.** Riverbank soil types will be determined for the Site based on previous investigation results, review of soil surveys in the vicinity (if applicable), and visual characterization of soil samples collected for chemical analysis. Soil types will be classified using the Unified Soil Classification System by ASTM D2487-17 Standards.
- **Riverbank Surface Protection.** Riverbank surface protection is defined as the amount of the riverbank that is covered and protected from erosion by woody debris, rooted vegetation, riprap, embedded boulders, revetments, or other materials. This information was obtained during the site reconnaissance. Results from the reconnaissance are detailed in Section 5.1 and summarized on Figure 6.
- **Visual Indicators of Active Riverbank Erosion.** Areas of active erosion were identified during the site reconnaissance.

River characteristics related to erosion will include:

- **Alignment of the River.** The location of the riverbank relative to bends in the river will be determined and the radius of the bends will be measured/approximated via site maps or online map resources.
- **Width and Depth of the River.** Changes in river channel width and depth can influence river velocity which results in higher erosion of the riverbank. Site-specific river width and depth information will be evaluated from the PHSS FS (EPA, 2016), site maps, topographic maps, bathymetric maps, or other online map resources.
- **Stream Velocity and Stage.** Stream velocities will be estimated for the T4 riverbank from the PHSS FS (EPA, 2016). Other sources that may be referenced include the USGS gauging station at the Morrison Bridge (USGS, 2020) and the USACE Hydrologic Engineering Center River Analysis System model for the lower Willamette River (USACE, 2016).
- **Wind- and Boat- Induced Waves.** Induced wave potential will be assessed using information on site use, the visual reconnaissance, and the PHSS FS (EPA, 2016).

5.3 Erodibility Evaluation

Data and information collected during the initial assessments will be evaluated using the quantitative Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model. The BANCS model can be tailored for the Site by adjusting site-specific parameters, to include but not limited to, bank height, bankful height, root depth and density, bank angle, surface protection, and riverbank material. The BANCS model predicts riverbank erosion using the erodibility potential of the bank determined by two factors: bank erosion hazard index (BEHI) and erosional forces caused by near-bank stress (NBS) of the river acting on the riverbank. The calculated BEHI and NBS values will be determined for representative sections of the riverbank to estimate riverbank erosion rates.

The erodibility evaluation will also include assessing the overall stability of the existing riverbank, conducting visual reconnaissance of the riverbank including visual observations of scarps and erosional features (completed), evaluating results from the topographic survey, evaluating bathymetric maps for depositional features, assessing potential for erosion of the bank from river/tidal action and wind- and boat-induced waves, and assessing potential for erosion of surface soil from overland flow. The riverbank erodibility evaluation will be based on a weight-of-evidence approach. Areas having an overall BEHI rating and/or NBS of moderate to extreme and physically observed areas of erosion (i.e., via site reconnaissance results and review of depositional features) will be weighted heavily in the weight-of-evidence approach for evaluating the riverbank erosion pathway. All assessment findings will be considered in the weight-of-evidence approach and will be used to support the results of the erodibility evaluation.

6.0 Schedule and Reporting

6.1 Schedule

The anticipated schedule is shown below.

Proposed Activity	Anticipated Schedule
Riverbank soil sampling	During low water levels (anticipated to be September/October)
Draft Riverbank Characterization Report to agencies	90 days after data validation is completed.

6.2 Reporting

The results of chemical and physical characterization of the T4 riverbank will be presented in a Riverbank Characterization Report in general accordance with the following outline.

1. Introduction
2. Background
3. Activities Completed
4. Deviation from Work Plan
5. Physical Characterization of Riverbank
    a. Topographic Survey Results
    b. Physical and Materials Characterization Results
    c. Erodibility Evaluation
6. Chemical Characterization of Riverbank
    a. Riverbank Soil Sampling Results

    b. Sediment Sampling Results
7. Riverbank Soil Source Control Evaluation
8. Conclusion
9. Appendices
    a. Soil/Sediment Sampling Field Documentation and Exploration Logs
    b. Analytical Laboratory Sample Analysis Report/Quality Assurance Review
    c. Physical/Material Characterization Field Documentation
    d. Photographs
    e. BANCS Model Results/Support Information

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Table 1
Contaminants of Interest
Terminal 4 Riverbank Sampling Work Plan
Portland, Oregon

Riverbank Area	Contaminant	Activity/Source
Berth 401	TPH-D	TPH release
	PCBs	Sediment Sampling
	Dioxin/furans	Sediment Sampling
North Side Slip 1	TPH-D	TPH release
	Dioxin/furans	Sediment Sampling
Berth 405	TPH-D	TPH release
	Dioxin/furans	Sediment Sampling
	PCBs	Sediment Sampling
Berth 409	TPH-D	TPH release
	PCBs	Sediment Sampling
	PAHs	Sediment Sampling
	Dioxin/furans	Sediment Sampling
Berth 408	TPH-D	TPH release
	Metals	Ore Handling/Release
	PAHs	Ashphalt release/
	PCBs	Sediment Sampling
	Dioxin/furans	Sediment Sampling
South Side of Slip 1	TPH-D	Proximity to TPH releases
	Metals	Ore Handling/Release, Soil Sampling
	PAHs	Soil Sampling
	PCBs	Sediment Sampling
	Pesticides	Soil Sampling
	Dioxin/furans	Sediment Sampling
Riverside of Slip 1	TPH-D	Proximity to TPH releases
Berth 411	TPH-D	TPH release
	PAHs	Pencil Pitch Handling, Sediment Sampling
	PCBs	Transformer release, Sediment Sampling
	Metals	Ore Handling/Release
Head of Slip 3	TPH-D	UPRR pipeline release
	PAHs	Soil Sampling, Sediment Sampling
	PCBs	Sediment Sampling
Former Berth 412	TPH-D	UPRR pipeline release
	PAHs	Soil Sampling, Sediment Sampling
	Metals	Ore Handling/Release
Riverside of Slip 3	TPH-D	Proximity to other releases
	PAHs	Soil Sampling, Sediment Sampling

Notes:

1. TPH = total petroleum hydrocarbons
2. PCBs = polychlorinated biphenyls
3. PAHs = polycyclic aromatic hydrocarbons

Table 2
Sample Locations and Numbering
Terminal 4 Riverbank Sampling Work Plan
Portland, Oregon

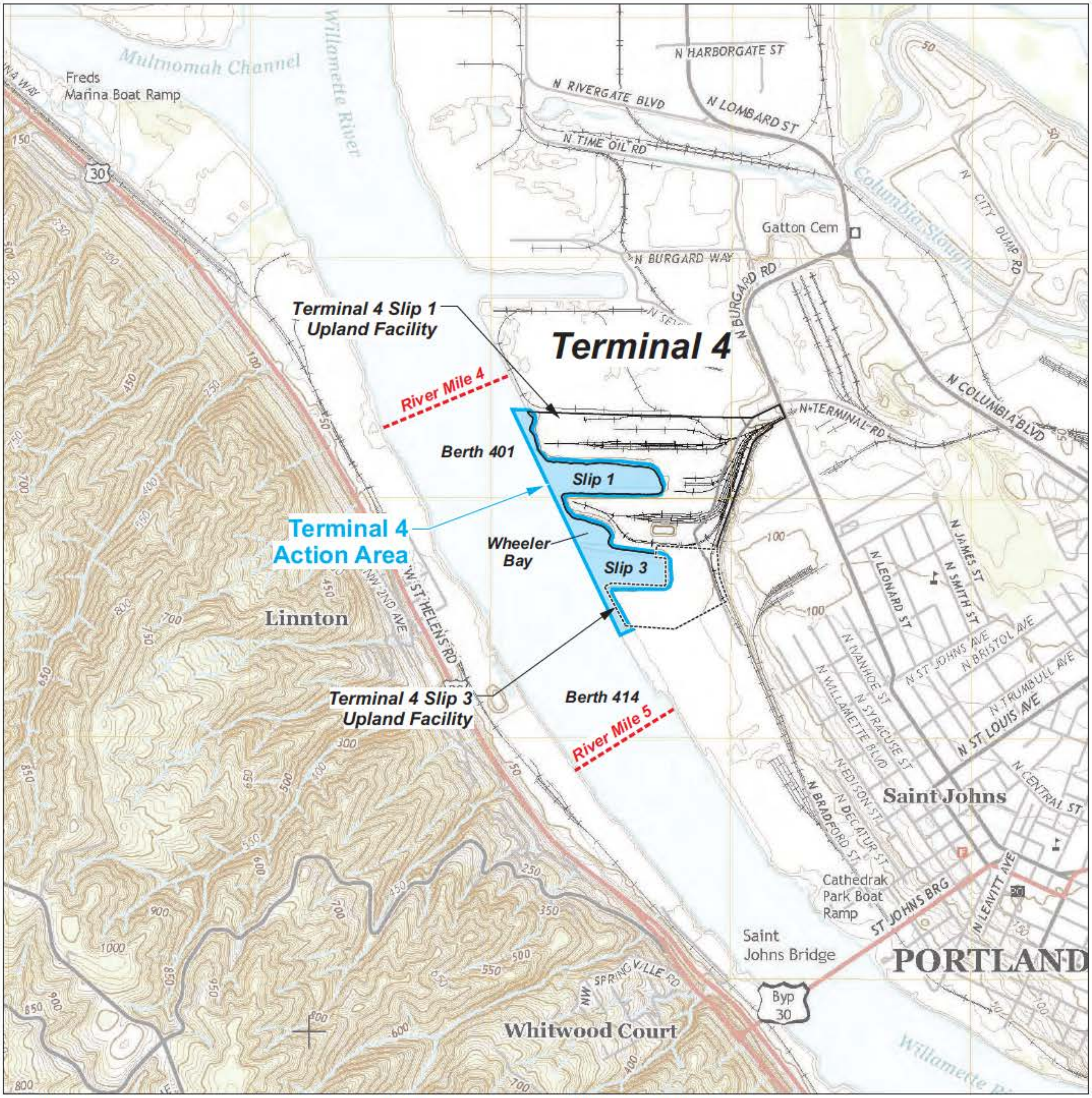
Riverbank Area	Riverbank Cell	Unit	Sample Name	Sample Type	Judgemental Sample Target	Coordinates	
						Northing	Easting
SOIL							
Berth 401	1	Upper	T4RB-1U-OS	Judgemental	Outfall - Drainage Basin S	715389.9	7618744.3
			T4RB-1U	Archive		715414.0	7618763.5
		Lower	T4RB-1L	Probabilistic	--	715396.5	7618668.5
	2	Upper	T4RB-2U	Probabilistic	--	715290.5	7618750.5
		Lower	T4RB-2L	Probabilistic	--	715284.3	7618691.9
	3	Upper	T4RB-3U	Probabilistic	--	715153.9	7618769.3
		Lower	T4RB-3L	Probabilistic	--	715145.1	7618716.5
	4	Upper	T4RB-4U-OR	Judgemental	Outfall - Drainage Basin R	715002.3	7618778.0
			T4RB-4U	Archive		715007.0	7618815.7
		Lower	T4RB-4L	Probabilistic	--	715017.1	7618761.7
	5	Upper	T4RB-5U	Probabilistic	--	714897.4	7618880.1
		Lower	T4RB-5L	Probabilistic	--	714886.7	7618838.1
North Side of Slip 1	6	Upper	T4RB-6U	Probabilistic	--	714831.9	7618977.8
		Lower	T4RB-6L	Probabilistic	--	714788.4	7618935.6
	7	Upper	T4RB-7U	Probabilistic	--	714826.2	7619105.7
		Lower	T4RB-7L	Probabilistic	--	714777.0	7619077.7
	8	Upper	T4RB-8U	Probabilistic	--	714814.0	7619266.8
		Lower	T4RB-8L	Probabilistic	--	714769.5	7619232.2
	9	Upper	T4RB-9U	Probabilistic	--	714814.8	7619391.0
		Lower	T4RB-9L	Probabilistic	--	714763.0	7619383.9
	10	Upper	T4RB-10U	Probabilistic	--	714806.5	7619535.6
		Lower	T4RB-10L	Probabilistic	--	714764.5	7619524.6
	11	Upper	T4RB-11U	Probabilistic	--	714804.2	7619699.3
		Lower	T4RB-11L	Probabilistic	--	714755.0	7619683.0
Berth 405	12	Upper	T4RB-12U	Probabilistic	--	714792.0	7619852.7
		Lower	T4RB-12L	Probabilistic	--	714751.1	7619835.0
	13	Upper	T4RB-13U	Probabilistic	--	714774.2	7620002.0
		Lower	T4RB-13L	Probabilistic	--	714731.1	7619982.4
	14	Upper	T4RB-14U	Probabilistic	--	714764.5	7620154.4
		Lower	T4RB-14L	Probabilistic	--	714719.4	7620134.4
	15	Upper	T4RB-15U	Probabilistic	--	714746.2	7620308.4
		Lower	T4RB-15L	Archive		714704.9	7620280.0
			T4RB-15L-OQ	Judgemental	Outfall - Drainage Basin Q	714627.2	7620316.9
Berth 409	16	Upper	T4RB-16U	Probabilistic	--	714600.2	7620420.5
		Lower	T4RB-16L	Archive		714598.3	7620393.6
			T4RB-16L-O52C	Judgemental	Outfall - City Outfall 52C	714572.0	7620389.5
			T4RB-16L-OO	Judgemental	Outfall - Drainage Basin O	714520.3	7620410.0
	17	Upper	T4RB-17U	Probabilistic	--	714443.2	7620478.7
		Lower	T4RB-17L	Archive		714453.1	7620455.9
			T4RB-17L-ON	Judgemental	Outfall - Drainage Basin N	714438.9	7620447.7
Berth 408	18	Upper	T4RB-18U	Probabilistic	--	714278.2	7620449.5
		Lower	T4RB-18L	Archive		714320.6	7620440.6
			T4RB-18L-OM	Probabilistic	Outfall - Drainage Basin M	714379.7	7620377.7
	19	Upper	T4RB-19U	Probabilistic	--	714269.4	7620267.2
		Lower	T4RB-19L	Probabilistic	--	714312.6	7620287.7

Table 2
Sample Locations and Numbering
Terminal 4 Riverbank Sampling Work Plan
Portland, Oregon

Riverbank Area	Riverbank Cell	Unit	Sample Name	Sample Type	Judgemental Sample Target	Coordinates	
						Northing	Easting
Berth 408	20	Upper	T4RB-20U	Probabilistic	--	714274.1	7620112.1
		Lower	T4RB-20L	Probabilistic	--	714314.4	7620128.6
	21	Upper	T4RB21U	Probabilistic	--	714279.2	7619964.6
		Lower	T4RB-21L	Probabilistic	--	714319.5	7619984.6
	22	Upper	T4RB-22U	Probabilistic	--	714286.6	7619812.6
		Lower	T4RB-22L	Probabilistic	--	714326.1	7619827.9
South Side of Slip 1	23	Upper	T4RB-23U	Probabilistic	--	714283.5	7619663.5
		Lower	T4RB-23L	Probabilistic	--	714322.1	7619678.8
	24	Upper	T4RB-24U	Probabilistic	--	714294.7	7619513.3
		Lower	T4RB-24L	Probabilistic	--	714326.3	7619530.7
	25	Upper	T4RB-25U	Probabilistic	--	714296.1	7619368.3
		Lower	T4RB-25L	Probabilistic	--	714329.3	7619379.6
	26	Upper	T4RB-26U	Probabilistic	--	714298.6	7619223.8
		Lower	T4RB-26L	Probabilistic	--	714326.4	7619242.8
Riverside of Slip 1	27	Upper	T4RB-27U	Probabilistic	--	714266.8	7619158.6
		Lower	T4RB-27L	Probabilistic	--	714307.3	7619123.0
	28	Upper	T4RB-28U	Probabilistic	--	714192.6	7619213.9
		Lower	T4RB-28L	Probabilistic	--	714184.0	7619150.0
	29	Upper	T4RB-29U	Probabilistic	--	714135.2	7619281.4
		Lower	T4RB-29L	Probabilistic	--	714089.6	7619241.5
Head of Slip 3	--	--	T4RB-K1	Judgemental	Outfall - Drainage Basin K1	713401.6	7620496.2
	--	--	T4RB-K2	Judgemental	Outfall - Drainage Basin K2	713362.7	7620497.1
	--	--	T4RB-BEBRA	Judgemental	Erosion in BEBRA wall	713328.3	7620512.1
	--	--	T4RB-OJ	Judgemental	Outfall - Drainage Basin J	713183.8	7620498.7
Former Berth 412	43	Upper	T4RB-43U	Probabilistic	--	712974.3	7620344.2
		Lower	T4RB-43L	Probabilistic	--	713008.8	7620365.5
	44	Upper	T4RB-44U-OD1	Judgemental	Outfall - Drainage Basin D	712981.8	7620274.2
			T4RB-44U	Archive		712978.5	7620192.6
		Lower	T4RB-44L	Probabilistic	--	713010.1	7620213.3
	45	Upper	T4RB-45U-OD2	Judgemental	Outfall - Drainage Basin D	712991.6	7620104.6
			T4RB-45U-OD3	Judgemental	Outfall - Drainage Basin D	712989.4	7620064.6
			T4RB-45U	Archive		712983.6	7620041.8
		Lower	T4RB-45L	Probabilistic	--	713012.7	7620059.4
	46	Upper	T4RB-46U	Probabilistic	--	712990.5	7619897.0
		Lower	T4RB-46L	Probabilistic	--	713019.2	7619911.9
	47	Upper	T4RB-47U	Probabilistic	--	712992.6	7619746.5
		Lower	T4RB-47L	Probabilistic	--	713025.1	7619755.4

Table 2
Sample Locations and Numbering
Terminal 4 Riverbank Sampling Work Plan
Portland, Oregon

Riverbank Area	Riverbank Cell	Unit	Sample Name	Sample Type	Judgemental Sample Target	Coordinates	
						Northing	Easting
Riverside of Slip 3	48	Upper	T4RB-48U	Probabilistic	--	712915.6	7619784.5
		Lower	T4RB-48L	Probabilistic	--	712913.0	7619739.4
	49	Upper	T4RB-49U	Probabilistic	--	712794.7	7619864.3
		Lower	T4RB-49L	Probabilistic	--	712786.0	7619808.7
	50	Upper	T4RB-50U	Probabilistic	--	712652.6	7619917.8
		Lower	T4RB-50L	Probabilistic	--	712646.9	7619874.9
	51	Upper	T4RB-51U	Probabilistic	--	712566.9	7619965.4
		Lower	T4RB-51L	Probabilistic	--	712559.2	7619923.8
		--	T4RB-51L-OD4	Judgemental	Outfall - Drainage Basin D	712524.7	7619907.9
SEDIMENT							
Former Berth 412	--	--	SG04	Judgemental	--	713072.1	7619832.6
	--	--	SG05	Judgemental	--	713062.2	7619991.6
	--	--	SG06	Judgemental	--	713054.5	7620136.1
	--	--	SG07	Judgemental	--	713046.5	7620289.7

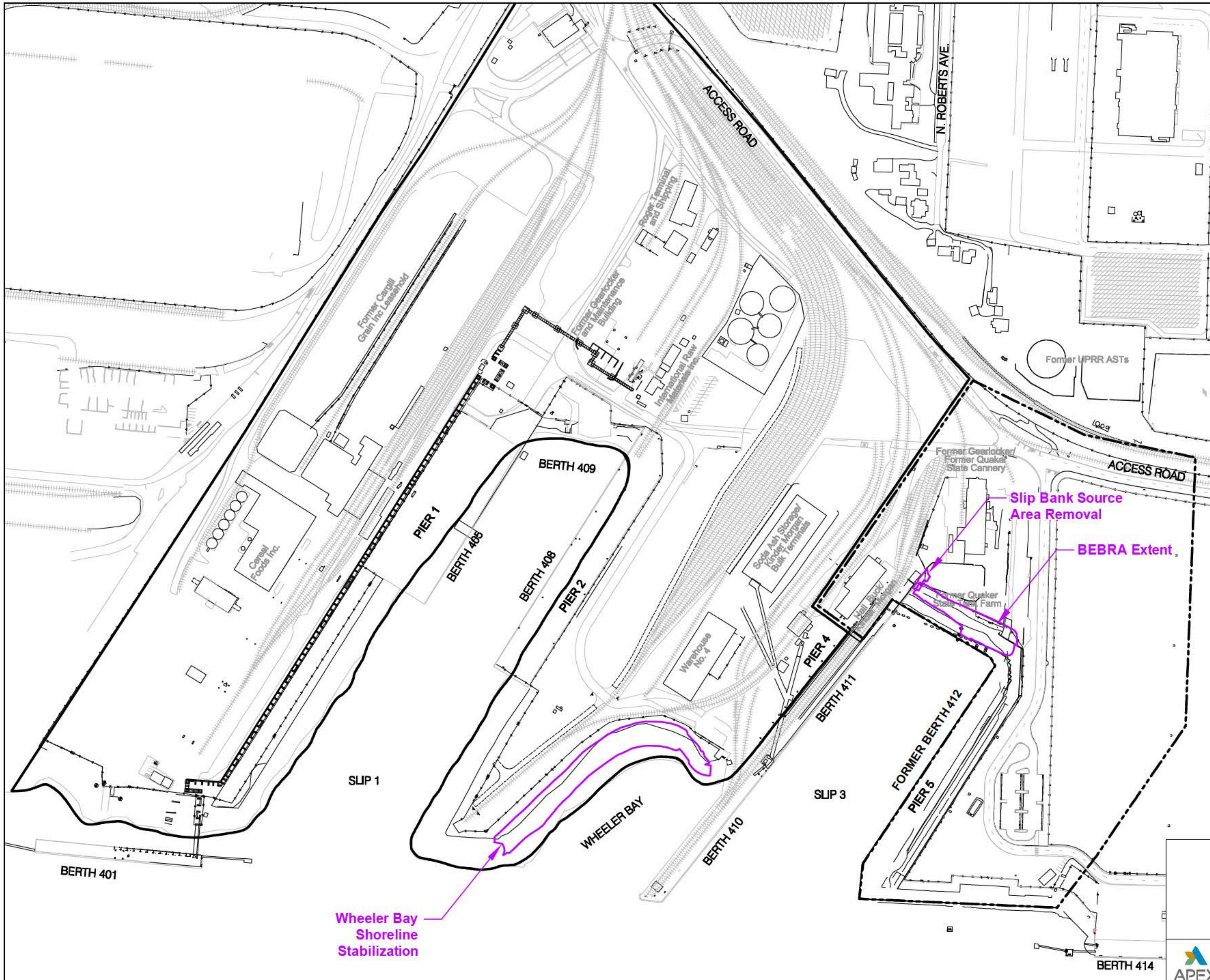


Note: Base map prepared from USGS 7.5-minute quadrangle of Linnton, OR, dated 2014 as provided by USGS.gov.

Facility Location Map

Riverbank Characterization Work Plan
Terminal 4 Action Area
Portland, Oregon

APEX Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	2372-07	Figure
	September 2020		1



Legend:

- Slip 1 Unit Boundary
- Slip 3 Unit Boundary
- Completed Remediation Actions/Source Control Actions

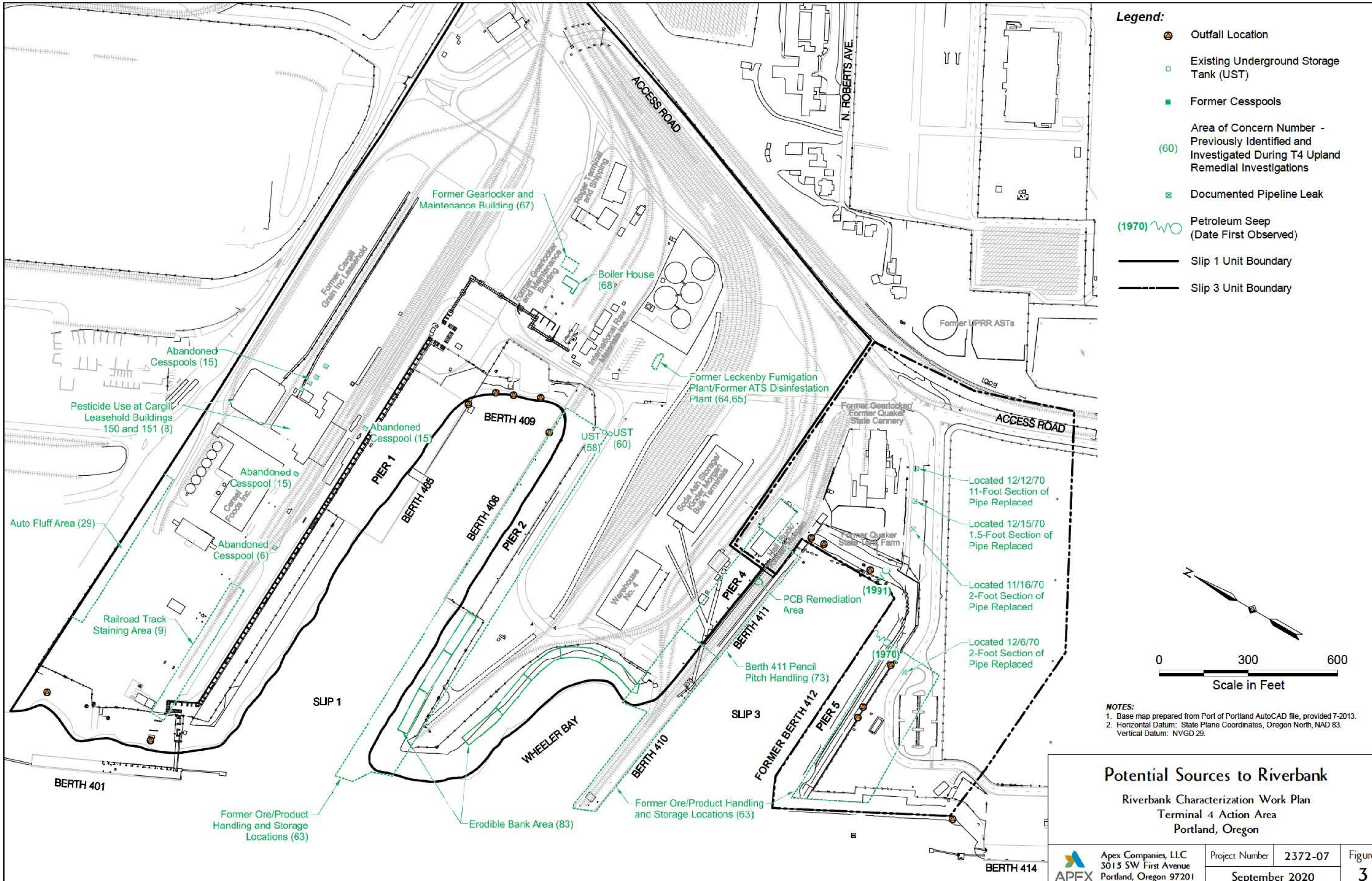
NOTES:

1. Base map prepared from Port of Portland AutoCAD file, provided 7-2013.
2. Horizontal Datum: State Plane Coordinates, Oregon North, NAD 83. Vertical Datum: NVGD 29.

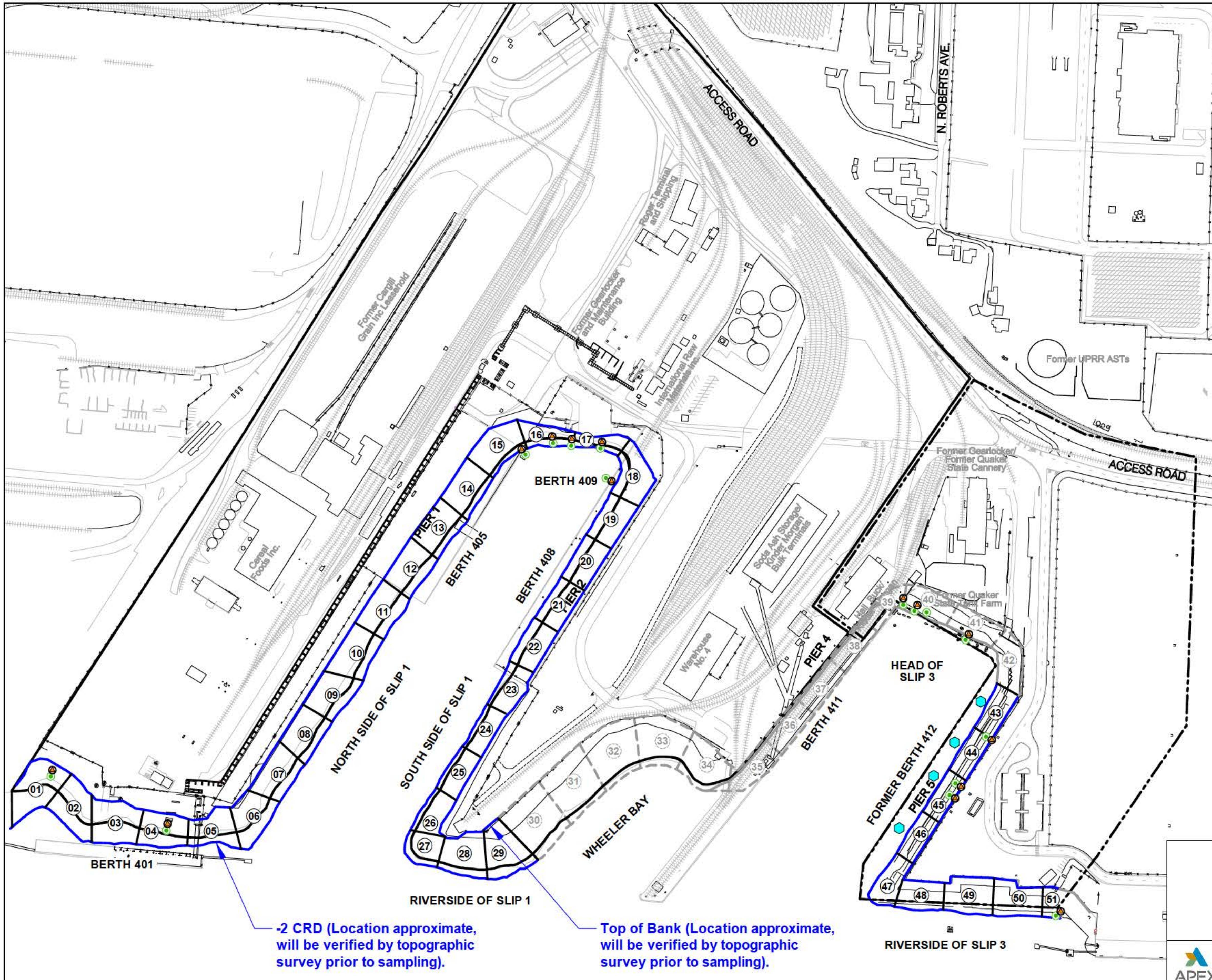
Facility Plan

Riverbank Characterization Work Plan
Terminal 4 Action Area
Portland, Oregon

APEX — Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number 2372-07 September 2020	Figure 2



Legend:
Outfall Location
Existing Underground Storage Tank (UST)
Former Cesspools
(60) Area of Concern Number - Previously Identified and Investigated During T4 Upland Remedial Investigations
Documented Pipeline Leak
(1970) Petroleum Seep (Date First Observed)
Slip 1 Unit Boundary
Slip 3 Unit Boundary
ACCESS ROAD
N. ROBERTS AVE.
Former Gearlocker and Maintenance Building (67)
Boiler House (68)
Former Cargill Grain Inc Leasehold
Abandoned Cesspools (15)
Pesticide Use at Cargill Leasehold Buildings 150 and 151 (8)
Abandoned Cesspool (15)
Abandoned Cesspool (15)
Abandoned Cesspool (6)
Auto Fluff Area (29)
Railroad Track Staining Area (9)
Cereal Foods Inc.
Former Leckenby Fumigation Plant/Former ATS Disinfestation Plant (64,65)
Former UPRR ASTs
Former Gearlocker/ Former Quaker State Cannery
Former Quaker State Tank Farm
UST (58)
UST (60)
BERTH 409
PIER 1
BERTH 405
BERTH 408
PIER 2
Soda Ash Storage/ Kinder Morgan Bulk Terminals
Warehouse No. 4
PIER 4
BERTH 411
PCB Remediation Area
(1991)
(1970)
Berth 411 Pencil Pitch Handling (73)
Located 12/12/70 11-Foot Section of Pipe Replaced
Located 12/15/70 1.5-Foot Section of Pipe Replaced
Located 11/16/70 2-Foot Section of Pipe Replaced
Located 12/6/70 2-Foot Section of Pipe Replaced
SLIP 1
SLIP 3
WHEELER BAY
BERTH 410
FORMER BERTH 412
PIER 5
BERTH 401
BERTH 414
Former Ore/Product Handling and Storage Locations (63)
Erodible Bank Area (83)
Former Ore/Product Handling and Storage Locations (63)
N
0 300 600
Scale in Feet
NOTES:
1. Base map prepared from Port of Portland AutoCAD file, provided 7-2013.
2. Horizontal Datum: State Plane Coordinates, Oregon North, NAD 83. Vertical Datum: NVGD 29.
Potential Sources to Riverbank
Riverbank Characterization Work Plan
Terminal 4 Action Area
Portland, Oregon
APEX
Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201
Project Number 2372-07
September 2020
Figure 3



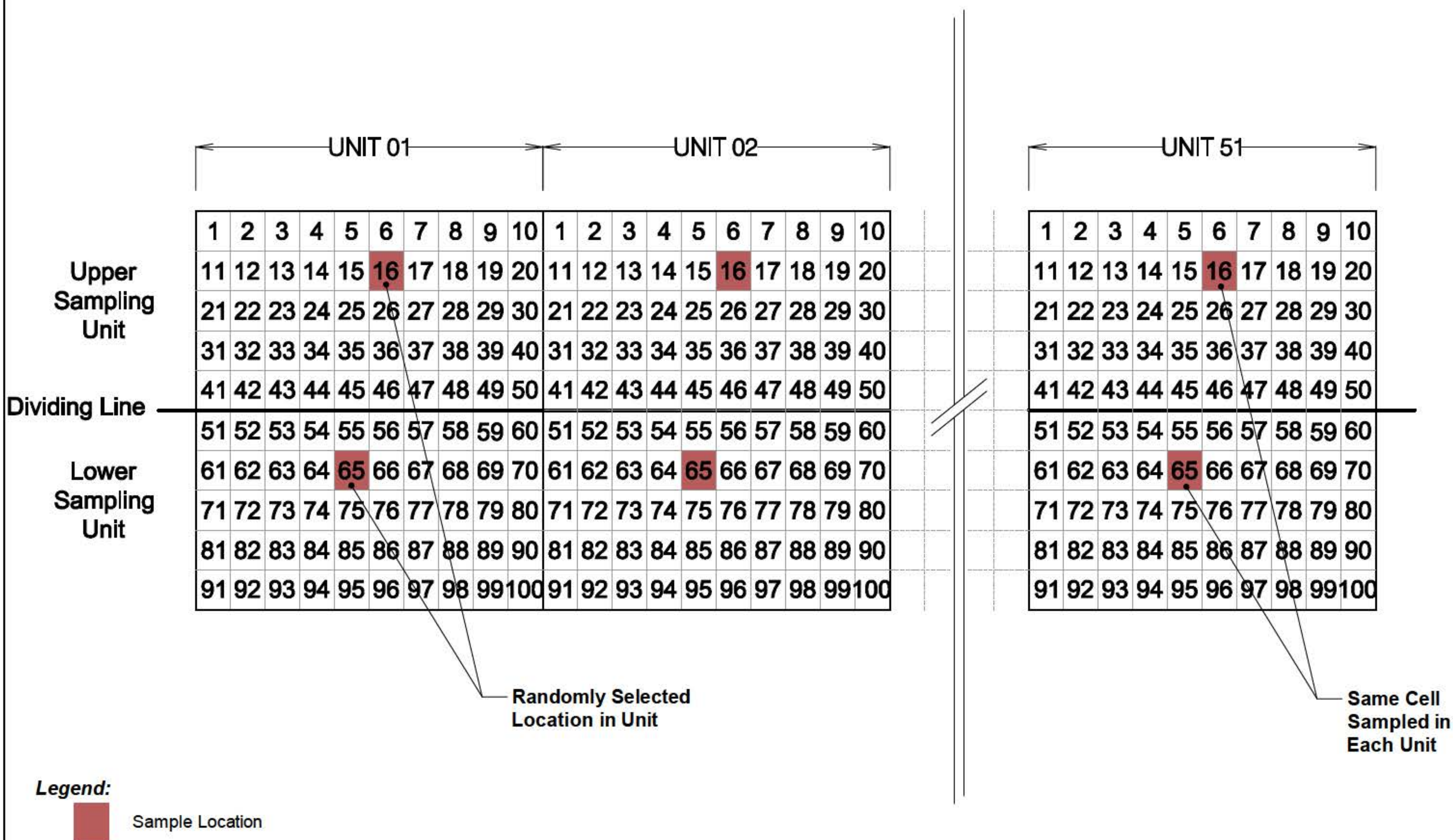
NOTES:
1. Base map prepared from Port of Portland AutoCAD file, provided 7-2013.
2. Horizontal Datum: State Plane Coordinates, Oregon North, NAD 83. Vertical Datum: NVGD 29.

Proposed Sample Locations

Riverbank Characterization Work Plan
Terminal 4 Action Area
Portland, Oregon

APEX
Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

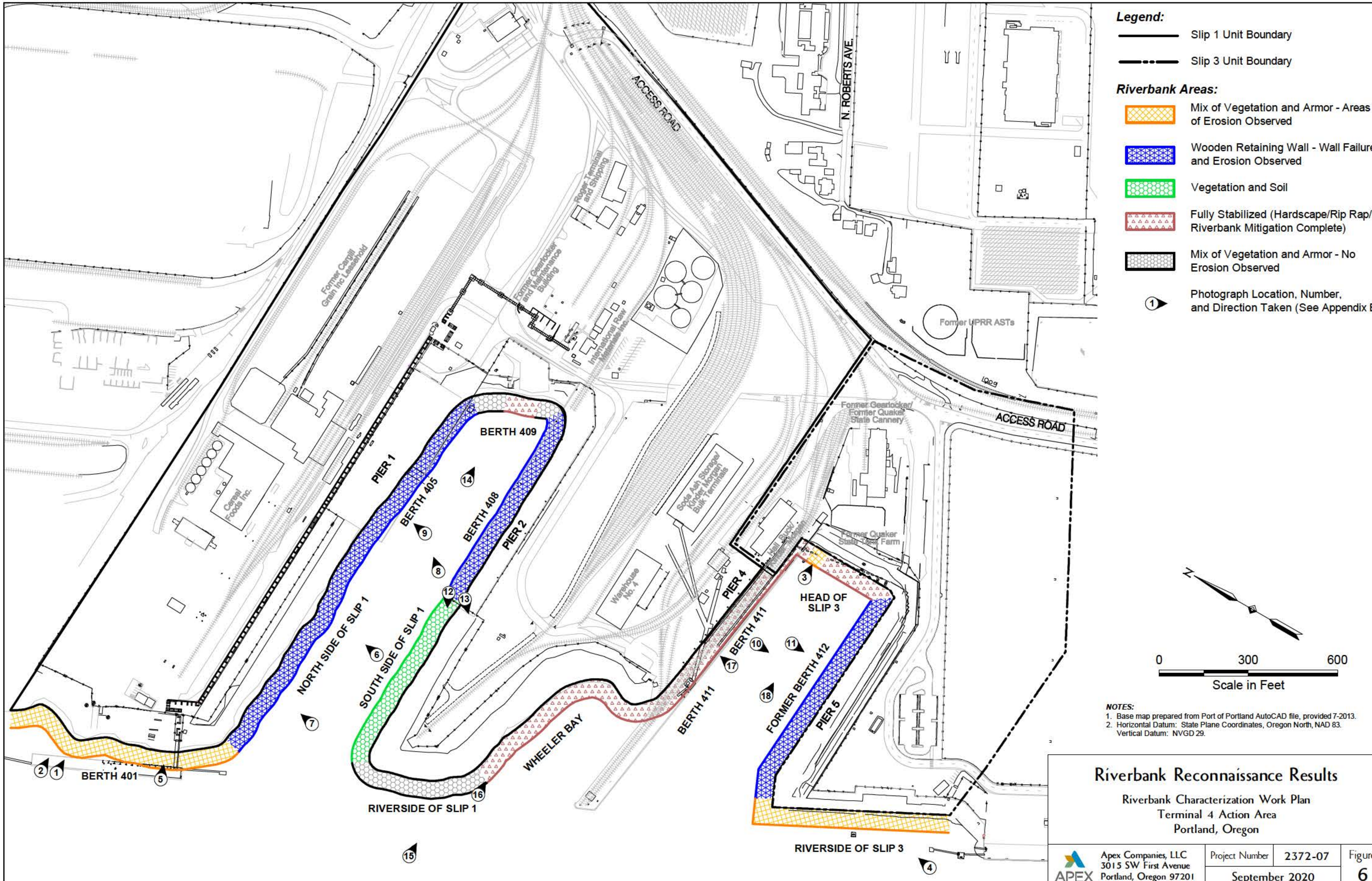
Project Number	2372-07	Figure
September 2020		4



Riverbank Modified Random Sample Location Schematic

Riverbank Characterization Work Plan
Terminal 4 Action Area
Portland, Oregon

Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	2372-07	Figure 5
	September 2020		



Legend:
Slip 1 Unit Boundary
Slip 3 Unit Boundary
Riverbank Areas:
Mix of Vegetation and Armor - Areas of Erosion Observed
Wooden Retaining Wall - Wall Failure and Erosion Observed
Vegetation and Soil
Fully Stabilized (Hardscape/Rip Rap/ Riverbank Mitigation Complete)
Mix of Vegetation and Armor - No Erosion Observed
Photograph Location, Number, and Direction Taken (See Appendix B)
ACCESS ROAD
N. ROBERTS AVE.
Former Cargill Grain Inc Leasehold
Cereal Foods Inc.
Former Gearlocker and Maintenance Building
Roger Terminal and Shipping
International Raw Materials Inc.
Former UPRR ASTs
Former Gearlocker/ Former Quaker State Cannery
Soda Ash Storage/ Kinder Morgan Bulk Terminals
Former Quaker State Tank Farm
Warehouse No. 4
BERTH 409
PIER 1
BERTH 405
BERTH 408
PIER 2
PIER 4
BERTH 411
HEAD OF SLIP 3
FORMER BERTH 412
PIER 5
NORTH SIDE OF SLIP 1
SOUTH SIDE OF SLIP 1
WHEELER BAY
BERTH 401
RIVERSIDE OF SLIP 1
RIVERSIDE OF SLIP 3
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
N
0
300
600
Scale in Feet
NOTES:
1. Base map prepared from Port of Portland AutoCAD file, provided 7-2013.
2. Horizontal Datum: State Plane Coordinates, Oregon North, NAD 83. Vertical Datum: NVGD 29.
Riverbank Reconnaissance Results
Riverbank Characterization Work Plan
Terminal 4 Action Area
Portland, Oregon
APEX
Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201
Project Number
2372-07
September 2020
Figure
6

Appendix A

Pre-Remedial Design Investigation Report Figures

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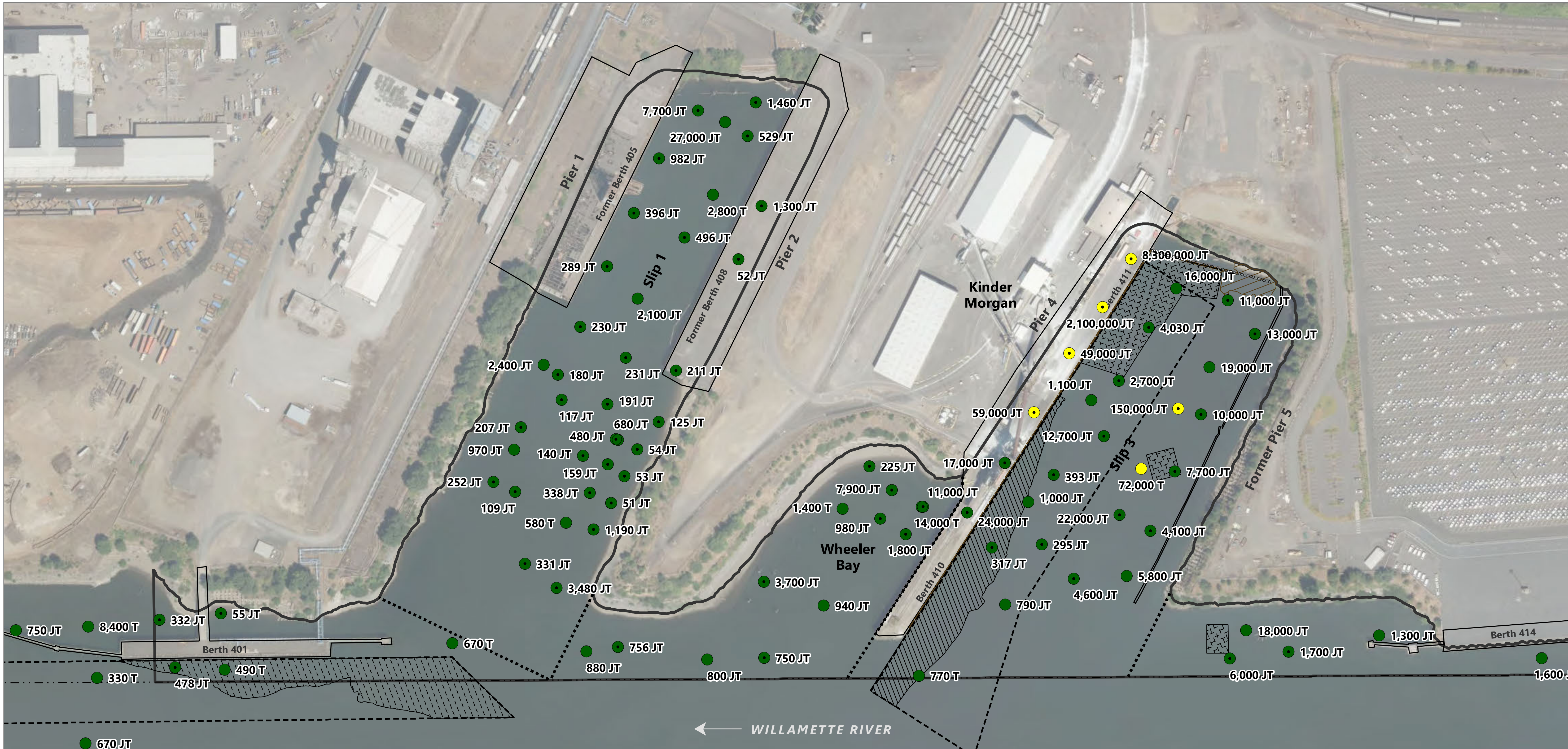


LEGEND:

- Sediment Decision Unit RM 4.5E
- Navigation Channel
- Shoreline Structures
- Sheet Pile Wall
- Timber Pinch Pile
- Site Subarea Boundaries
- Potential Maintenance Dredging
- Berth 410 Maintenance Dredging (2017)
- Berth 401 Maintenance Dredging (2015)
- Terminal 4 Early Action Dredging (2008)
- Early Action Sediment Cap
- PDI Surface Sediment Sampling Locations
- Pre-RD Group Surface Sediment Sampling Locations

Total PAH (µg/kg)

- ≤ 30,000
- > 30,000 (Exceeds RAL)

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 1991) Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2018.
4. Pre-RD Group data were collected by Geosyntec Consultants in 2018 and are shown for reference only.
5. Gray values with a "U" qualifier represent non-detects.
6. Values with a "T" qualifier indicate a calculated or averaged result.
7. "J+" qualifier indicates an estimated value, biased high.
8. "N" qualifier indicates the presumptive evidence of a compound.
9. SDU boundary extends approximately 1,000 feet upstream from the extent shown.

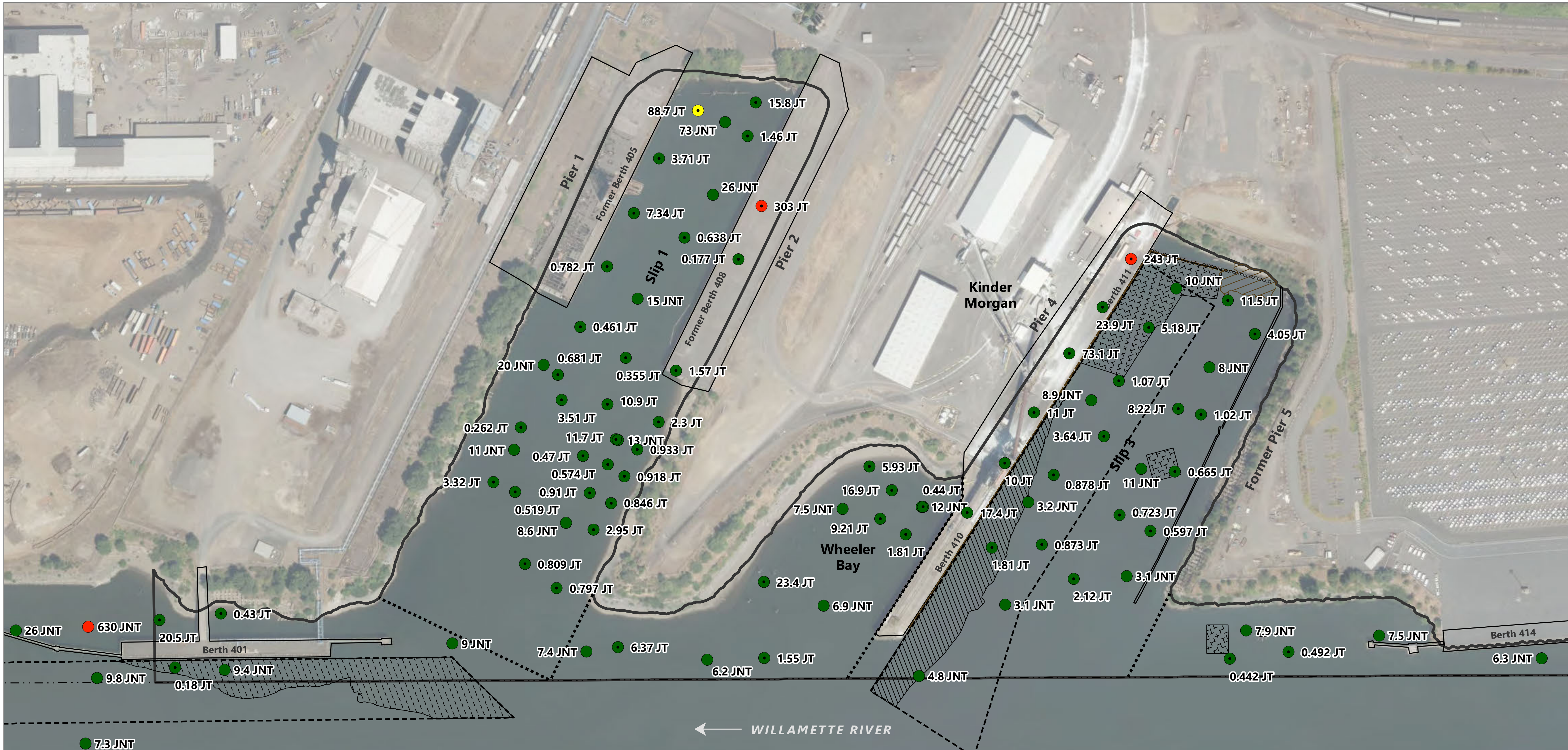
0 250
Feet

Publish Date: 2020/06/04, 8:56 AM | User: eiverson
Filepath: \\orcas\GIS\Jobs\PortOfPortland_0332\PortlandHarborFS\Maps\Reports\PDISamplingReport\AQ_PDI2019_Fig6-1a_PreliminaryResults_Surface_tPAH.mxd

ANCHOR QEA

Figure 6-1a
PDI and Pre-RD Group Surface Sediment Concentrations – Total PAHs
Pre-Remedial Design Investigation Summary Report
Terminal 4 Remedy

DRAFT



LEGEND:

- Sediment Decision Unit RM 4.5E
- Navigation Channel
- Shoreline Structures
- Sheet Pile Wall
- Timber Pinch Pile
- Site Subarea Boundaries
- Potential Maintenance Dredging
- Berth 410 Maintenance Dredging (2017)
- Berth 401 Maintenance Dredging (2015)
- Terminal 4 Early Action Dredging (2008)
- Early Action Sediment Cap
- PDI Surface Sediment Sampling Locations
- Pre-RD Group Surface Sediment Sampling Locations

Total PCBs (µg/kg)

- ≤ 75
- 75.1 - 200 (Exceeds RAL)
- > 200 (Exceeds PTW-Highly Toxic)

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 1991) Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2018.
4. Pre-RD Group data were collected by Geosyntec Consultants in 2018 and are shown for reference only.
5. Gray values with a "U" qualifier represent non-detects.
6. Values with a "T" qualifier indicate a calculated or averaged result.
7. "J+" qualifier indicates an estimated value, biased high.
8. "N" qualifier indicates the presumptive evidence of a compound.
9. SDU boundary extends approximately 1,000 feet upstream from the extent shown.

0 250
Feet

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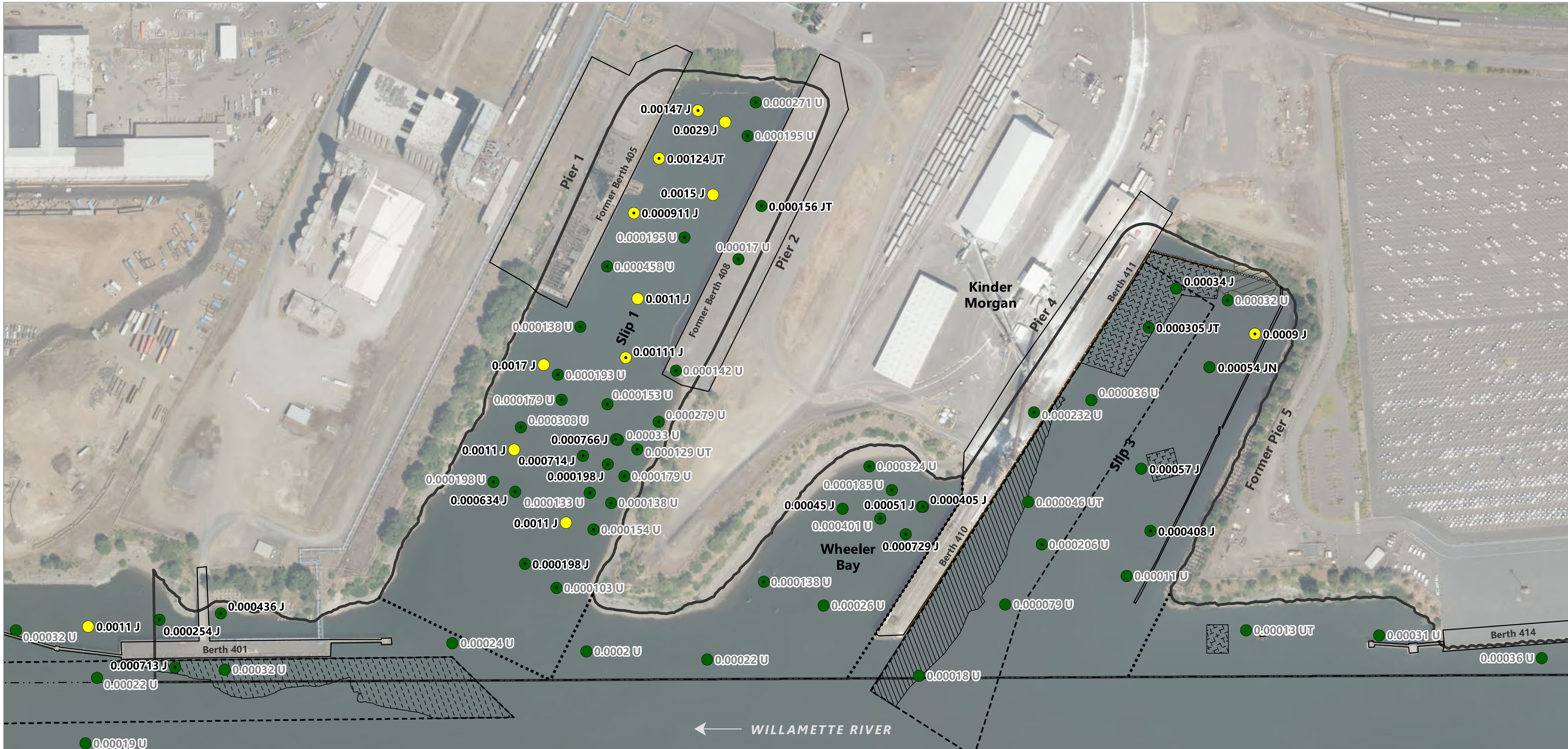
Filepath: \\orcas\GIS\Jobs\PortOfPortland_0332\PortlandHarborFS\Maps\Reports\PDISamplingReport\AQ_PDI2019_Fig6-1b_PreliminaryResults_Surface_tPCB.mxd

ANCHOR QEA

Figure 6-1b
PDI and Pre-RD Group Surface Sediment Concentrations – Total PCBs
Pre-Remedial Design Investigation Summary Report
Terminal 4 Remedy

DRAFT



LEGEND:

- Sediment Decision Unit RM 4.5E
- Navigation Channel
- Shoreline Structures
- Sheet Pile Wall
- Timber Pinch Pile
- Site Subarea Boundaries
- Potential Maintenance Dredging
- Berth 410 Maintenance Dredging (2017)
- Berth 401 Maintenance Dredging (2015)
- Terminal 4 Early Action Dredging (2008)
- Early Action Sediment Cap
- PDI Surface Sediment Sampling Locations
- Pre-RD Group Surface Sediment Sampling Locations

1,2,3,7,8-PeCDD (µg/kg)

- ≤ 0.0008
- 0.00081 - 0.01 (Exceeds RAL)
- > 0.01 (Exceeds PTW-Highly Toxic)

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 1991) Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2018.
4. Pre-RD Group data were collected by Geosyntec Consultants in 2018 and are shown for reference only.
5. Gray values with a "U" qualifier represent non-detects.
6. Values with a "T" qualifier indicate a calculated or averaged result.
7. "J+" qualifier indicates an estimated value, biased high.
8. "N" qualifier indicates the presumptive evidence of a compound.
9. SDU boundary extends approximately 1,000 feet upstream from the extent shown.

0 250
Feet

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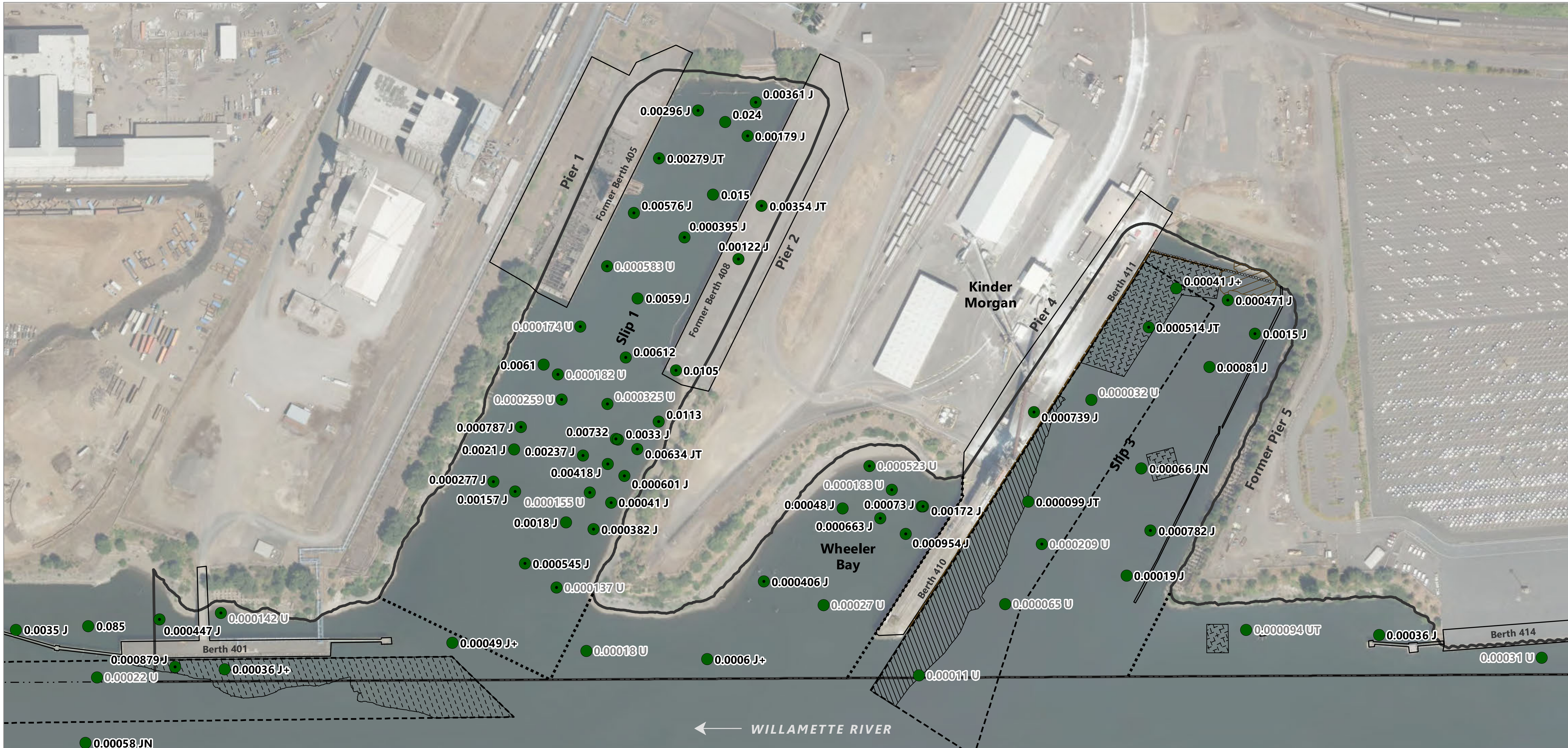
ANCHOR QEA

Figure 6-1c
PDI and Pre-RD Group Surface Sediment Concentrations – 1,2,3,7,8-PeCDD

DRAFT



LEGEND:

- Sediment Decision Unit RM 4.5E
- Navigation Channel
- Shoreline Structures
- Sheet Pile Wall
- Timber Pinch Pile
- Site Subarea Boundaries
- Potential Maintenance Dredging
- Berth 410 Maintenance Dredging (2017)
- Berth 401 Maintenance Dredging (2015)
- Terminal 4 Early Action Dredging (2008)
- Early Action Sediment Cap
- PDI Surface Sediment Sampling Locations
- Pre-RD Group Surface Sediment Sampling Locations

2,3,4,7,8-PeCDF (µg/kg)

- ≤ 0.2
- > 0.2 (Exceeds RAL/PTW-Highly Toxic)

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 1991) Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2018.
4. Pre-RD Group data were collected by Geosyntec Consultants in 2018 and are shown for reference only.
5. Gray values with a "U" qualifier represent non-detects.
6. Values with a "T" qualifier indicate a calculated or averaged result.
7. "J+" qualifier indicates an estimated value, biased high.
8. "N" qualifier indicates the presumptive evidence of a compound.
9. SDU boundary extends approximately 1,000 feet upstream from the extent shown.

0 250
Feet

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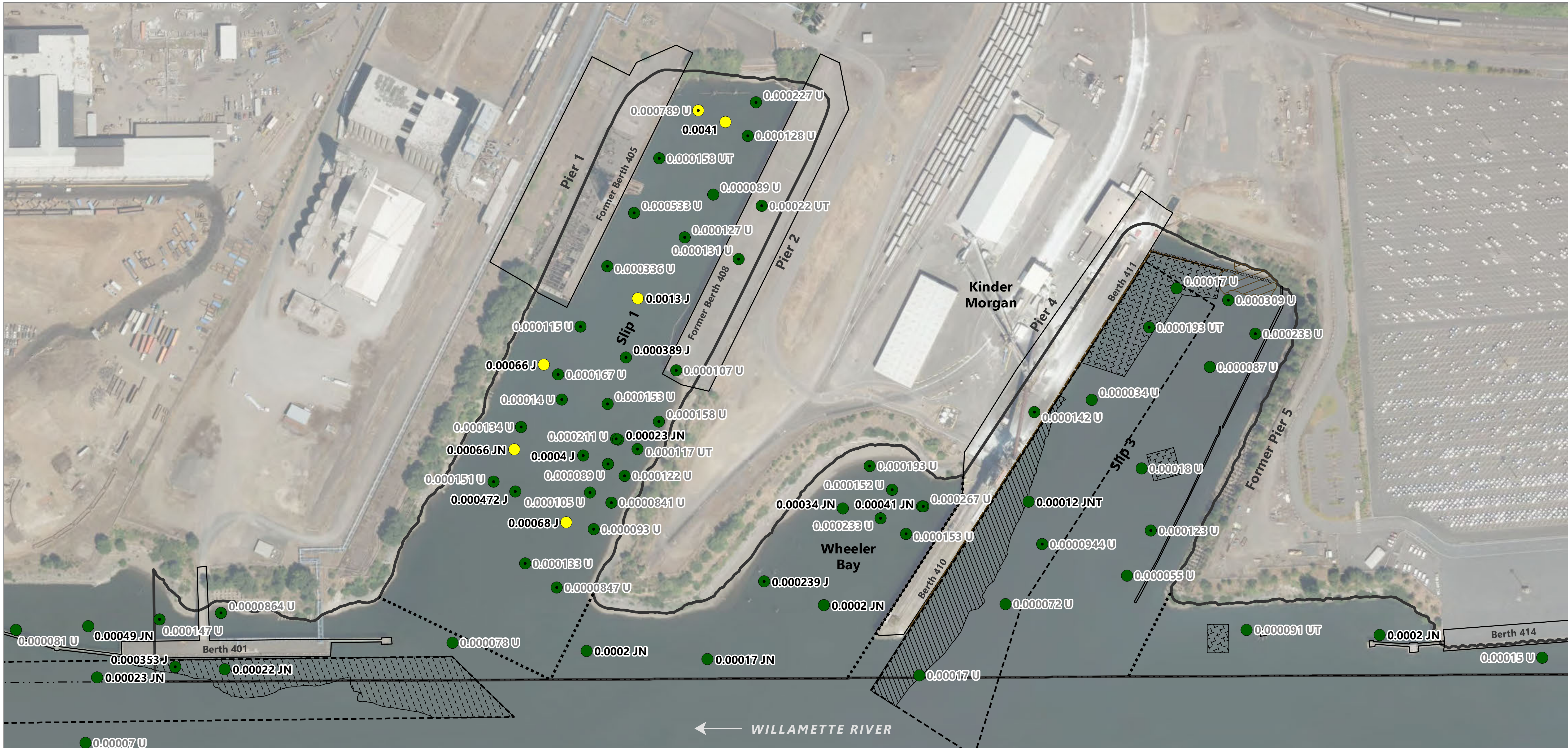
ANCHOR QEA

Figure 6-1d
PDI and Pre-RD Group Surface Sediment Concentrations – 2,3,4,7,8-PeCDF
Pre-Remedial Design Investigation Summary Report
Terminal 4 Remedy

DRAFT



LEGEND:

- Sediment Decision Unit RM 4.5E
- Navigation Channel
- Shoreline Structures
- Sheet Pile Wall
- Timber Pinch Pile
- Site Subarea Boundaries
- Potential Maintenance Dredging
- Berth 410 Maintenance Dredging (2017)
- Berth 401 Maintenance Dredging (2015)
- Terminal 4 Early Action Dredging (2008)
- Early Action Sediment Cap
- PDI Surface Sediment Sampling Locations
- Pre-RD Group Surface Sediment Sampling Locations

2,3,7,8-TCDD (µg/kg)

- ≤ 0.0006
- 0.00061 - 0.01 (Exceeds RAL)
- > 0.01 (Exceeds PTW-Highly Toxic)

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 1991) Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2018.
4. Pre-RD Group data were collected by Geosyntec Consultants in 2018 and are shown for reference only.
5. Gray values with a "U" qualifier represent non-detects.
6. Values with a "T" qualifier indicate a calculated or averaged result.
7. "J+" qualifier indicates an estimated value, biased high.
8. "N" qualifier indicates the presumptive evidence of a compound.
9. SDU boundary extends approximately 1,000 feet upstream from the extent shown.

0 250
Feet

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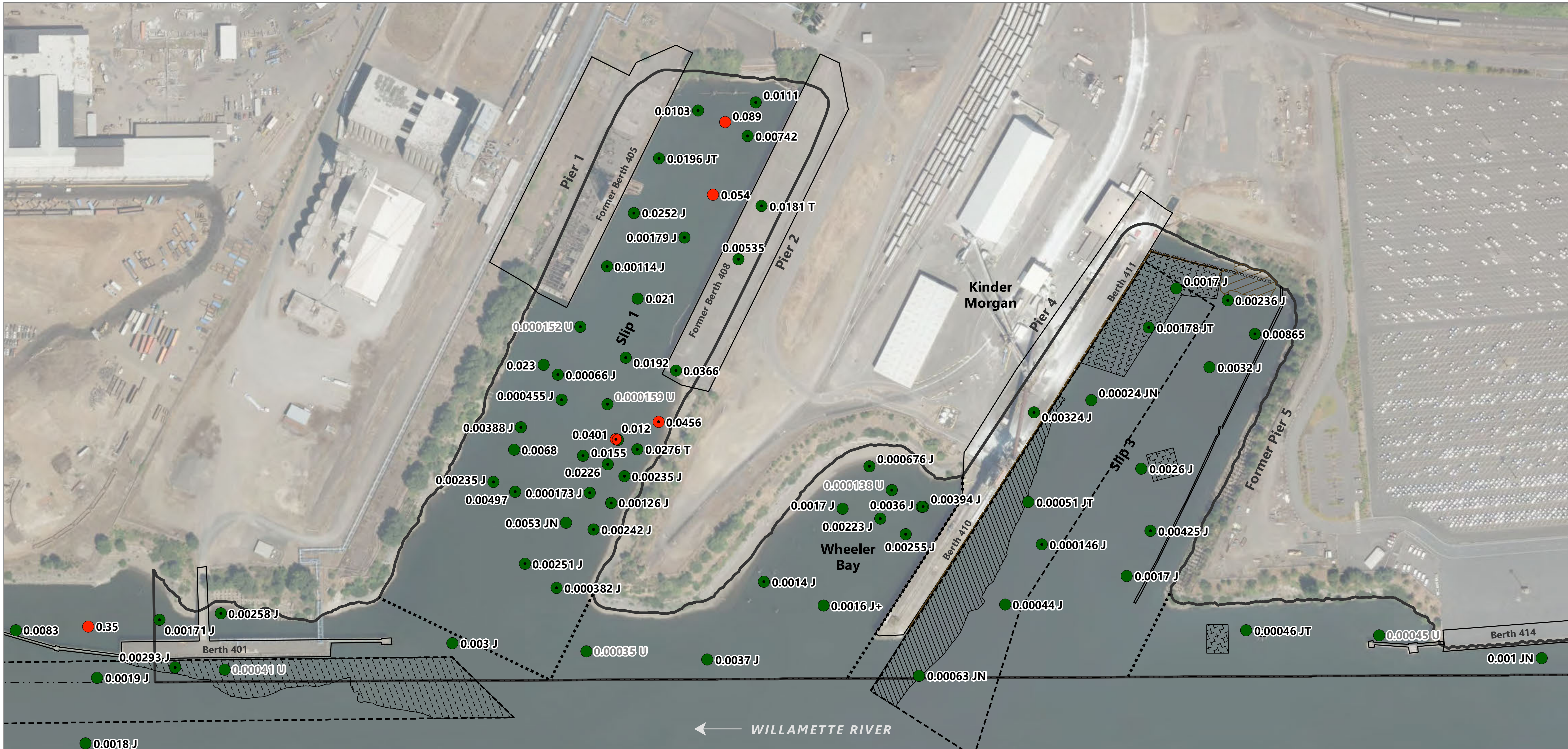
ANCHOR QEA

Figure 6-1e
PDI and Pre-RD Group Surface Sediment Concentrations – 2,3,7,8-TCDD

DRAFT



LEGEND:

- Sediment Decision Unit RM 4.5E
- Navigation Channel
- Shoreline Structures
- Sheet Pile Wall
- Timber Pinch Pile
- Site Subarea Boundaries
- Potential Maintenance Dredging
- Berth 410 Maintenance Dredging (2017)
- Berth 401 Maintenance Dredging (2015)
- Terminal 4 Early Action Dredging (2008)
- Early Action Sediment Cap
- PDI Surface Sediment Sampling Locations
- Pre-RD Group Surface Sediment Sampling Locations

1,2,3,4,7,8-HxCDF (µg/kg)

- ≤ 0.04
- > 0.04 (Exceeds PTW-Highly Toxic)

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 1991) Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2018.
4. Pre-RD Group data were collected by Geosyntec Consultants in 2018 and are shown for reference only.
5. Gray values with a "U" qualifier represent non-detects.
6. Values with a "T" qualifier indicate a calculated or averaged result.
7. "J+" qualifier indicates an estimated value, biased high.
8. "N" qualifier indicates the presumptive evidence of a compound.
9. SDU boundary extends approximately 1,000 feet upstream from the extent shown.

0 250
Feet

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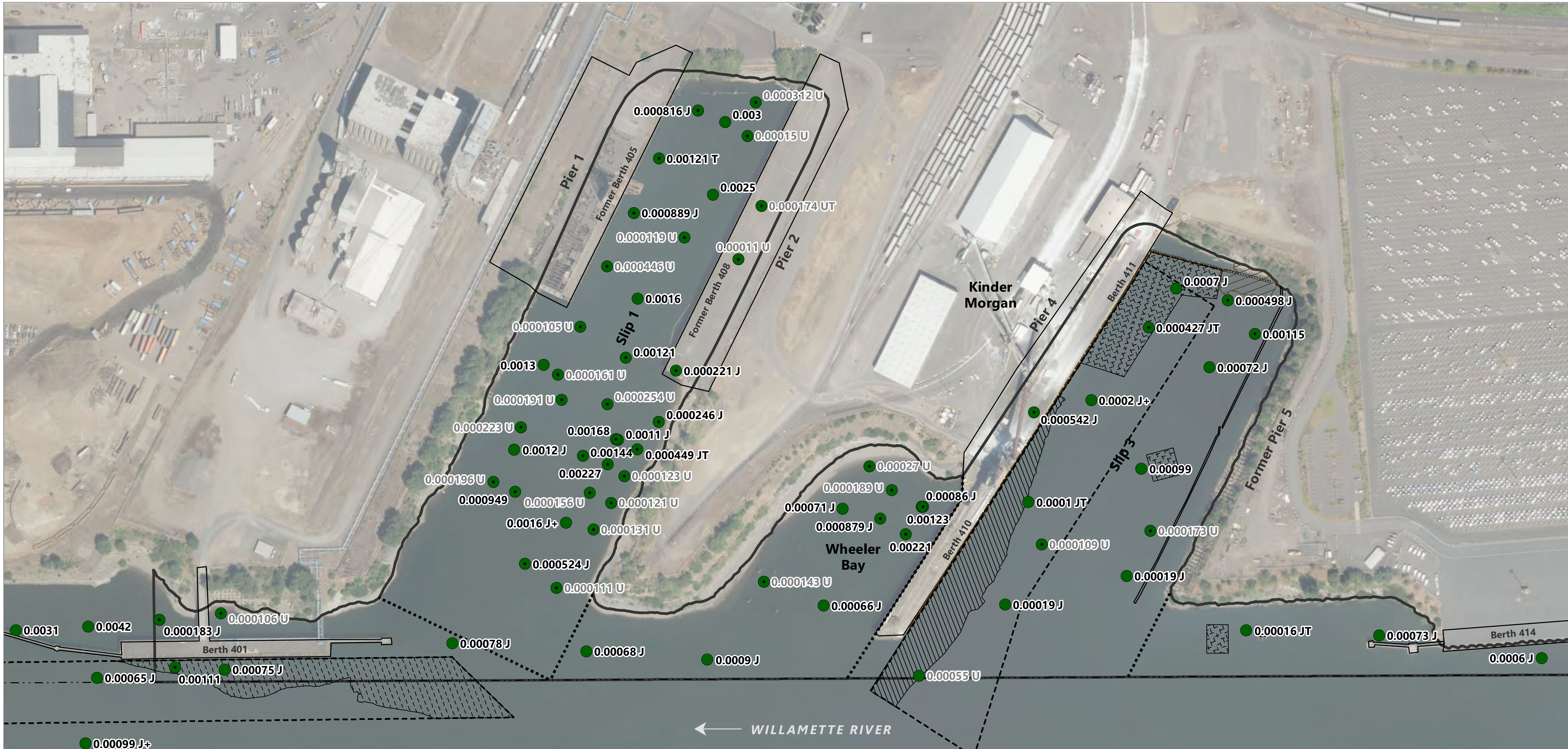
Figure 6-1f

PDI and Pre-RD Group Surface Sediment Concentrations – 1,2,3,4,7,8-HxCDF

Pre-Remedial Design Investigation Summary Report
Terminal 4 Remedy

DRAFT



LEGEND:

- Sediment Decision Unit RM 4.5E
- Navigation Channel
- Shoreline Structures
- Sheet Pile Wall
- Timber Pinch Pile
- Site Subarea Boundaries
- Potential Maintenance Dredging
- Berth 410 Maintenance Dredging (2017)
- Berth 401 Maintenance Dredging (2015)
- Terminal 4 Early Action Dredging (2008)
- Early Action Sediment Cap
- PDI Surface Sediment Sampling Locations
- Pre-RD Group Surface Sediment Sampling Locations

2,3,7,8-TCDF (µg/kg)

- ≤ 0.6
- > 0.6 (Exceeds PTW-Highly Toxic)

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 1991) Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2018.
4. Pre-RD Group data were collected by Geosyntec Consultants in 2018 and are shown for reference only.
5. Gray values with a "U" qualifier represent non-detects.
6. Values with a "T" qualifier indicate a calculated or averaged result.
7. "J+" qualifier indicates an estimated value, biased high.
8. "N" qualifier indicates the presumptive evidence of a compound.
9. SDU boundary extends approximately 1,000 feet upstream from the extent shown.

0 250
Feet

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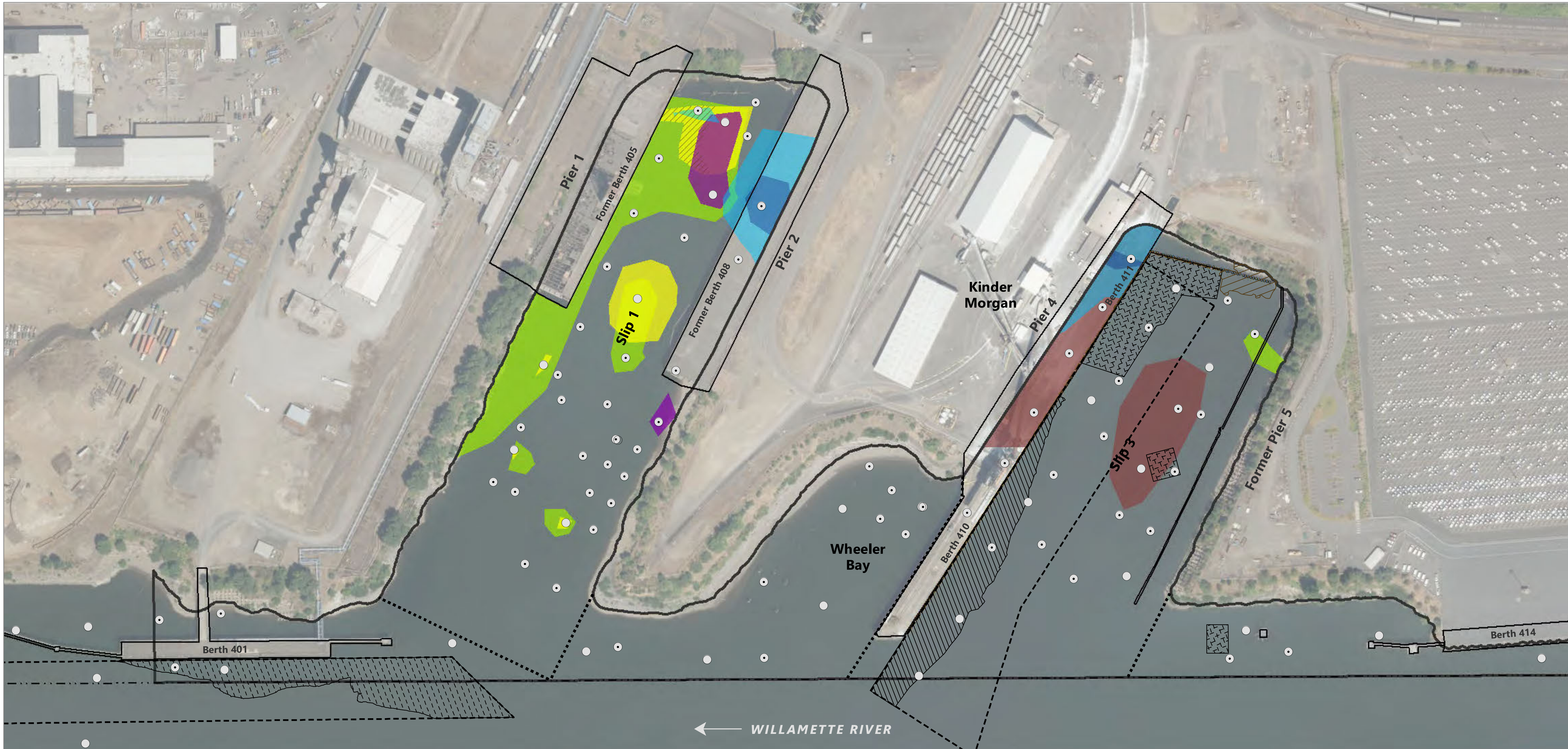
Figure 6-1g
PDI and Pre-RD Group Surface Sediment Concentrations – 2,3,7,8-TCDF
Pre-Remedial Design Investigation Summary Report
Terminal 4 Remedy

DRAFT



LEGEND:

- Sediment Decision Unit RM 4.5E
- Navigation Channel
- Shoreline Structures
- Sheet Pile Wall
- Timber Pinch Pile
- Site Subarea Boundaries
- Potential Maintenance Dredging
- Early Action Sediment Cap
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- Berth 401 Maintenance Dredging (2015)
- Terminal 4 Early Action Dredging (2008)
- PDI Surface Sediment Sampling Locations
- Pre-RD Group Surface Sediment Sampling Locations

Surface SMA Footprints

- Total PCBs > PTW-Highly Toxic (200 µg/kg)
- Total PCBs > RAL (75 µg/kg)
- 2,3,7,8-TCDD > RAL (0.0006 µg/kg)
- 1,2,3,4,7,8-HxCDF > PTW-Highly Toxic (0.04 µg/kg)
- Total PAHs > RAL (30,000 µg/kg)
- 1,2,3,7,8-PeCDD > RAL (0.0008 µg/kg)
- D/F Detection Limit Above RAL

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 1991) Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2018.
4. SDU boundary extends approximately 1,000 feet upstream from the extent shown.
5. PDI Surface SMAs are an initial refinement of ROD SMAs; additional refinement will occur during remedial design.

0 250
Feet

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Figure 6-3
PDI Surface SMA Footprints for Each COC
Pre-Remedial Design Investigation Summary Report
Terminal 4 Remedy

Appendix B

Historical Riverbank Analytical Results

Table B-1
Historical Riverbank Soil Sampling Results - Polycyclic Aromatic Hydrocarbons
Terminal 4, Port of Portland
Portland, Oregon

Sample ID	Date	Sample Type	Depth (feet bgs)	Benzo(a) anthracene	Benzo(a)pyrene	Benzo(b)fluor anthene	Benzo(k)fluor anthene	Chrysene	Dibenzo(a,h) anthracene	Indeno(1,2,3-cd) pyrene	Benzo(g,h,i) perylene	Fluoranthene
				Concentration in micrograms per kilogram (µg/kg)								
			ROD RAL	--	--	--	--	--	--	--	--	--
			ESD RAL	--	--	--	--	--	--	--	--	--
			PTW	--	--	--	--	--	--	--	--	--
			PHSS CULs - Riverbank Soil/Sediment	--	--	--	--	--	--	--	--	--
			JSCS Screening Level Values	1,050	1,450	--	13,000	1,290	1,300	100	300	2,230
Slip 1												
T4S1S-23	09/12/2005	Composite	0 - 1	30.8	48.1	59.6	37.9	77.4	14.9	46.4	50.9	28.9
T4S1S-24	09/12/2005	Composite	0 - 1	15.1	20.9	21.3	17.2	17.9	4.79 J	15.4	17.5	26.5
T4S1S-25	09/12/2005	Composite	0 - 1	62.3	89.1	102	58.8	70.7	20.5	62.8	70.2	104
T4S1S-26	09/13/2005	Composite	0 - 1	581	776	874	597	898	151	514	611	962
T4S1S-26A	09/13/2005	Discrete	0 - 1	62.5	92.4	89.4	84.8	79.2	17.9	55.4	61.4	87.5
T4S1S-26B	09/13/2005	Discrete	0 - 1	2380	1460	2270	2070	4170	160	433	358	7990
T4S1S-26C	09/13/2005	Discrete	0 - 1	68	97.4	94	90.2	87.3	17.7	54.8	60.1	95.4
T4S1S-26D	09/13/2005	Discrete	0 - 1	1110	1830	1500	1300	1590	183	790	926	1640
T4S1S-27	09/13/2005	Composite	0 - 1	597	786	916	583	705	194	581	655	986
T4S1S-27A	09/13/2005	Discrete	0 - 1	2700	3560	3690	3240	3590	795	2280	2560	4650
T4S1S-27B	09/13/2005	Discrete	0 - 1	320	445	485	409	393	64.2	181	181	511
T4S1S-27C	09/13/2005	Discrete	0 - 1	62.9	104	91	88.6	83.2	18.2 J	60.6	74.4	88.1
T4S1S-27D	09/13/2005	Discrete	0 - 1	74.4	110	107	101	98.7	20.4 J	61.4	68.3	113
T4S1S-28	09/13/2005	Composite	0 - 1	1390	1660	2020	1230	1650	394	1130	1240	2390
T4S1S-28A	09/13/2005	Discrete	0 - 1	6580	7790	8010	7260	8190	1530	4460	4770	11300
T4S1S-28B	09/13/2005	Discrete	0 - 1	61.6	85.1	87.7	80.7	83.4	16.7 J	49.1 J	56.3	93.5
T4S1S-28C	09/13/2005	Discrete	0 - 1	48.4	74.5	85.4	64	64	10.9 J	30.5	30.5	80.1
T4S1S-28D	09/13/2005	Discrete	0 - 1	263	376	378	331	357	73.3	247	290	400
T4S1S-29	09/13/2005	Composite	0 - 1	3610	4920	4440	3660	4510	1060	3500	4160	5780
T4S1S-30	09/13/2005	Composite	0 - 1	1590	1880	2300	1270	1850	427	1220	1280	2650
T4S1S-30A	09/13/2005	Discrete	0 - 1	2810	3610	3560	3240	3600	662	1950	2160	4340
T4S1S-30C	09/13/2005	Discrete	0 - 1	1500	1840	1690	1620	1720	322	950	997	2110
T4S1S-30D	09/13/2005	Discrete	0 - 1	16.4	8.08 J	7.49 J	5.34 J	24.3	13.9 U	13.9 U	13.9 U	139 J
S-37	09/04/2008	Composite	0 - 1	293	342	359	273	357	163 U	231	278	486
S-38	09/04/2008	Composite	0 - 1	120	158	169	128	164	34.5	114	141	212
S-39	09/04/2008	Composite	0 - 1	391	453	477	398	498	171 U	318	372	542
S-40	09/04/2008	Composite	0 - 1	2560	2520	2560	2190	2850	633	1710	1780	4330
S-41	09/04/2008	Composite	0 - 1	4610	4620	5110	4150	5440	987	2770	2860	7380

Please see notes at end of table.

Table B-1
Historical Riverbank Soil Sampling Results - Polycyclic Aromatic Hydrocarbons
Terminal 4, Port of Portland
Portland, Oregon

Sample ID	Date	Sample Type	Depth (feet bgs)	Benzo(a) anthracene	Benzo(a)pyrene	Benzo(b)fluor anthene	Benzo(k)fluor anthene	Chrysene	Dibenzo(a,h) anthracene	Indeno(1,2,3-cd) pyrene	Benzo(g,h,i) perylene	Fluoranthene
Concentration in micrograms per kilogram (µg/kg)												
			ROD RAL	--	--	--	--	--	--	--	--	--
			ESD RAL	--	--	--	--	--	--	--	--	--
			PTW	--	--	--	--	--	--	--	--	--
			PHSS CULs - Riverbank Soil/Sediment	--	--	--	--	--	--	--	--	--
			JSCS Screening Level Values	1,050	1,450	--	13,000	1,290	1,300	100	300	2,230
Slip 3												
SB-1-0.5	02/01/2007	Discrete	0.5	6360	7600	5570	5590	7850	2830 U	5680	7710	11800
SB-1-3	02/01/2007	Discrete	3	1730	2050	2150	1340	1760	283	1280	1570	2720
SB-2-0.5	02/01/2007	Discrete	0.5	300	383	379	335	380	94	373	467	468
SB-3-2.5	02/01/2007	Discrete	2.5	102	142	120	96.5	120	77 U	107	147	181
SB-4-3.0	02/01/2007	Discrete	3	27100	28500	29600	23300	30800	7430	19100	20300	46900
SB-5-0.5	02/01/2007	Discrete	0.5	1210	1390	1390	1090	1420	779 U	944	1090	1870
SB-6-0.5	02/01/2007	Discrete	0.5	134	181	173	147	209	73.6 U	149	188	196
SB-7-0.5	02/01/2007	Discrete	0.5	184	226	213	201	205	73.5 U	163	180	256
SB-8-0.5	02/01/2007	Discrete	0.5	85.7	121	109	98.1	99.4	73.2 U	132	180	122
SB-9-0.5	02/01/2007	Discrete	0.5	891	1160	1000	886	894	246	856	961	1420
SB-10-0.5	02/01/2007	Discrete	0.5	573 U	688	710	573 U	643	573 U	573 U	573 U	806
SB-16-0.5	03/06/2007	Discrete	0.5	658	663	1150	596	829	480 U	480 U	480 U	847
SB-17-0.5	03/06/2007	Discrete	0.5	187	205	242	170	179	146 U	146 U	147	261
SB-23-0.5	03/06/2007	Discrete	0.5	1480 U	1480 U	2220	1480 U	1510	1480 U	1480 U	1480 U	1480
T4S3PP-RB1-0.5	11/17/2005	Discrete	0.5	51300	50500	60700	41300	54000	14000	28300	29400	90600
T4S3PP-RB2-0.5	11/17/2005	Discrete	0.5	35700	36000	45300	27900	38300	10400	21200	22600	59100
T4S3PP-RB3-0.5	11/17/2005	Discrete	0.5	1110	1300	1460	1020	1180	370	779	858	1730
T4S3PP-RB4-1.0	11/17/2005	Discrete	1	212	277	257	214	279	36.4	114	112	343
T4S3PP-RB5-1.0	11/17/2005	Discrete	1	1990	2120	2910	1400	2170	612	1280	1400	3420
T4S3PP-RB6-1.0	11/17/2005	Discrete	1	23.5	32.6	29.3	25.8	31.2	14.9 U	14.9 U	14.9 U	35.1

Please see notes at end of table.

Table B-1
Historical Riverbank Soil Sampling Results - Polycyclic Aromatic Hydrocarbons
Terminal 4, Port of Portland
Portland, Oregon

Sample ID	Date	Sample Type	Depth (feet bgs)	Pyrene	Acenaphthene	Acenaphthylene	Anthracene	Fluorene	Naphthalene	Phenanthrene	Bap Eq	Total PAHs
				Concentration in micrograms per kilogram (µg/kg)								
			ROD RAL	--	--	--	--	--	--	--	--	13,000
			ESD RAL	--	--	--	--	--	--	--	--	30,000
			PTW	--	--	--	--	--	140,000	--	106,000	--
			PHSS CULs - Riverbank Soil/Sediment	--	--	--	--	--	--	--	85	23,000
			JSCS Screening Level Values	1,520	300	200	845	536	561	1,170	--	--
Slip 1												
T4S1S-23	9/12/2005	Composite	0 - 1	22.3	14.2 U	4.74 J	17.6	14.2 U	14.2 U	10.9 J	80.5 T	0 T
T4S1S-24	9/12/2005	Composite	0 - 1	19.5	14.3 U	14.3 U	14.3 U	14.3 U	14.3 U	9.65 J	32.6 T	221 T
T4S1S-25	9/12/2005	Composite	0 - 1	75.1	15.8 U	15.8 U	6.51 J	15.8 U	15.8 U	37.7	138 T	791 T
T4S1S-26	9/13/2005	Composite	0 - 1	883	70.1 U	35.7 J	57 J	70.1 U	30.3 J	234	1,184 T	7,274 T
T4S1S-26A	9/13/2005	Discrete	0 - 1	83.6	13.6 U	13.6 U	3.4 J	13.6 U	13.6 U	23.2	140 T	768 T
T4S1S-26B	9/13/2005	Discrete	0 - 1	7220	27.1	48.8	206	28.7	5.55 J	361	2,339 T	29,188 T
T4S1S-26C	9/13/2005	Discrete	0 - 1	86.7	13.9 U	13.9 U	3.63 J	13.9 U	13.9 U	25.4	146 T	808 T
T4S1S-26D	9/13/2005	Discrete	0 - 1	1750	77.3 U	108	99.6	77.3 U	83.2	443	2,485 T	13,430 T
T4S1S-27	9/13/2005	Composite	0 - 1	722	97.4	18.7 J	93.5	48 J	69.2	376	1,248 T	7,428 T
T4S1S-27A	9/13/2005	Discrete	0 - 1	3440	375	114	471	207	269	1680	5,550 T	33,621 T
T4S1S-27B	9/13/2005	Discrete	0 - 1	402	9.59 J	13.6 U	19.7	7.51 J	13.6 U	141	649 T	3,583 T
T4S1S-27C	9/13/2005	Discrete	0 - 1	94.2	54.7 U	54.7 U	54.7 U	54.7 U	54.7 U	28.5 J	153 T	930 T
T4S1S-27D	9/13/2005	Discrete	0 - 1	105	54.5 U	54.5 U	54.5 U	54.5 U	54.5 U	35 J	165 T	1,030 T
T4S1S-28	9/13/2005	Composite	0 - 1	1640	151	67.6 U	166	114	28.3 J	1040	2,633 T	16,277 T
T4S1S-28A	9/13/2005	Discrete	0 - 1	8280	843	18.2 J	717	825	107	6300	11,959 T	76,980 T
T4S1S-28B	9/13/2005	Discrete	0 - 1	85.7	55.2 U	55.2 U	55.2 U	55.2 U	55.2 U	29.8 J	130 T	868 T
T4S1S-28C	9/13/2005	Discrete	0 - 1	63.1	13.8 U	13.8 U	13.8 U	13.8 U	13.8 U	22.4	108 T	608 T
T4S1S-28D	9/13/2005	Discrete	0 - 1	379	68.4 U	68.4 U	24.8 J	68.4 U	68.4 U	137	572 T	3,393 T
T4S1S-29	9/13/2005	Composite	0 - 1	5490	164 J	176	314	116 J	388	1710	7,506 T	43,998 T
T4S1S-30	9/13/2005	Composite	0 - 1	1870	183	69.2 U	173	72.5	39.5 J	972	2,947 T	17,812 T
T4S1S-30A	9/13/2005	Discrete	0 - 1	3610	295 J	344 U	251 J	105 J	344 U	1630	5,432 T	32,167 T
T4S1S-30C	9/13/2005	Discrete	0 - 1	1770	171	55.2 U	162	70.3	33.2 J	873	2,740 T	15,856 T
T4S1S-30D	9/13/2005	Discrete	0 - 1	147	1180	347 U	520 U	1240	6480	1830	18.7 T	11,532 T
S-37	9/4/2008	Composite	0 - 1	558	163 U	163 U	163 U	163 U	163 U	181	539 T	3,847 T
S-38	9/4/2008	Composite	0 - 1	201	30.6 U	30.6 U	30.6 U	30.6 U	30.6 U	146	246 T	1,664 T
S-39	9/4/2008	Composite	0 - 1	514	171 U	171 U	171 U	171 U	171 U	225	697 T	4,701 T
S-40	9/4/2008	Composite	0 - 1	3560	866	144 U	479	973	144 U	4,360	4,058 T	31,515 T
S-41	9/4/2008	Composite	0 - 1	5540	761	149 U	556	662	149	4,470	7,276 T	50,140 T

Please see notes at end of table.

Table B-1
Historical Riverbank Soil Sampling Results - Polycyclic Aromatic Hydrocarbons
Terminal 4, Port of Portland
Portland, Oregon

Sample ID	Date	Sample Type	Depth (feet bgs)	Pyrene	Acenaphthene	Acenaphthylene	Anthracene	Fluorene	Naphthalene	Phenanthrene	Bap Eq	Total PAHs
Concentration in micrograms per kilogram (µg/kg)												
			ROD RAL	--	--	--	--	--	--	--	--	13,000
			ESD RAL	--	--	--	--	--	--	--	--	30,000
			PTW	--	--	--	--	--	140,000	--	106,000	--
			PHSS CULs - Riverbank Soil/Sediment	--	--	--	--	--	--	--	85	23,000
			JSCS Screening Level Values	1,520	300	200	845	536	561	1,170	--	--
Slip 3												
SB-1-0.5	2/1/2007	Discrete	0.5	16700	2830 U	2830 U	2830 U	2830 U	2830 U	2830 U	11,343 T	84,766 T
SB-1-3	2/1/2007	Discrete	3	3100	75 U	141	165	75 U	76.3	462	2,985 T	18,905 T
SB-2-0.5	2/1/2007	Discrete	0.5	474	73.8 U	73.8 U	73.8 U	73.8 U	73.8 U	165	616 T	4,003 T
SB-3-2.5	2/1/2007	Discrete	2.5	202	77 U	77 U	77 U	77 U	77 U	77 U	223 T	1,490 T
SB-4-3.0	2/1/2007	Discrete	3	33700	4480	3030 U	4510	3030 U	3030 U	24800	45,871 T	305,068 T
SB-5-0.5	2/1/2007	Discrete	0.5	1600	779 U	779 U	779 U	779 U	779 U	779 U	2,244 T	14,731 T
SB-6-0.5	2/1/2007	Discrete	0.5	236	73.6 U	73.6 U	73.6 U	73.6 U	73.6 U	130	278 T	1,964 T
SB-7-0.5	2/1/2007	Discrete	0.5	227	73.5 U	73.5 U	73.5 U	73.5 U	73.5 U	97.4	339 T	2,173 T
SB-8-0.5	2/1/2007	Discrete	0.5	129	73.2 U	73.2 U	73.2 U	73.2 U	73.2 U	73.2 U	200 T	1,333 T
SB-9-0.5	2/1/2007	Discrete	0.5	1190	72 U	72 U	96.6	72 U	72 U	481	1,770 T	10,226 T
SB-10-0.5	2/1/2007	Discrete	0.5	717	573 U	573 U	573 U	573 U	573 U	573 U	1,132 T	6,716 T
SB-16-0.5	3/6/2007	Discrete	0.5	829	480 U	480 U	480 U	480 U	480 U	480 U	1,168 T	7,733 T
SB-17-0.5	3/6/2007	Discrete	0.5	271	146 U	146 U	146 U	146 U	146 U	146 U	345 T	2,247 T
SB-23-0.5	3/6/2007	Discrete	0.5	1510	1480 U	1480 U	1480 U	1480 U	1480 U	1480 U	1,926 T	15,601 T
T4S3PP-RB1-0.5	11/17/2005	Discrete	0.5	63100 J	6370	373 U	8350	3680	1820	48600	82,714 T	552,207 T
T4S3PP-RB2-0.5	11/17/2005	Discrete	0.5	44100 J	3980	314 U	5420	2670	675	32500	59,448 T	386,003 T
T4S3PP-RB3-0.5	11/17/2005	Discrete	0.5	1320 J	107	15.3 U	107	60.8	15.3 U	672	2,108 T	12,090 T
T4S3PP-RB4-1.0	11/17/2005	Discrete	1	308 J	18.6	14.6 U	20.4	14.6 U	14.6 U	141	393 T	2,355 T
T4S3PP-RB5-1.0	11/17/2005	Discrete	1	2420 J	198	15.6 U	307	133	28.8	1760	3,492 T	22,158 T
T4S3PP-RB6-1.0	11/17/2005	Discrete	1	35.7 J	14.9 U	14.9 U	14.9 U	14.9 U	14.9 U	15	48.7 T	289 T

Notes:

1. bgs = Below ground surface.
2. -- = Not analyzed.
3. J = The result is an estimated value.
4. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
5. UJ = The not detected value is estimated at the reporting limit.
6. D = Dilution.
7. T = Result calculated or selected from >1 reported value.
8. Total values calcaulated according to Appendix A of the Portland Harbor RI/FS, June 2016
9. Shaded values represent detected analyte concentrations exceeding CUL or JSCS SLV if there is no riverbank CUL.
10. PHSS CULs = Portland Harbor Superfund Site Cleanup Values, Portland Harbor Record of Decision, Table 17 (Errata #2, January 2020 update), EPA, 2017.
11. JSCS Screening Level Value from Joint Source Control Strategy, DEQ/EPA, 2005.
12. ROD RAL = Remedial Action Levels from the Portland Harbor Superfund Site ROD (2017).
13. ESD RAL = Remedial Action Levels from the Portland Harbor Superfund Site Explanation of Significant Differences (ESD, 2019).
14. PTW = Principal Threat Waste threshold from the Portland Harbor Superfund Site ROD (2017).

Table B-2
Historical Riverbank Soil Sampling Results - Total Petroleum Hydrocarbons
Terminal 4, Port of Portland
Portland, Oregon

Sample ID	Date	Sample Type	Depth (feet bgs)	Diesel	Oil
			ROD RAL	--	--
			ESD RAL	--	--
			PTW	--	--
			PHSS CULs - Riverbank Soil/Sediment	91	--
			JSCS Screening Level Values	--	--
Concentration in milligrams per kilogram (mg/kg)					
Slip 3					
SB-1-0.5	02/01/2007	Discrete	0.5	108	496
SB-1-3	02/01/2007	Discrete	3	69.9 U	388
SB-2-0.5	02/01/2007	Discrete	0.5	13.5 U	27 U
SB-3-2.5	02/01/2007	Discrete	2.5	14.7 U	29.3 U
SB-4-3.0	02/01/2007	Discrete	3	297	520
SB-5-0.5	02/01/2007	Discrete	0.5	14.7 U	147
SB-6-0.5	02/01/2007	Discrete	0.5	13.7 U	60.2
SB-7-0.5	02/01/2007	Discrete	0.5	13.8 U	27.6 U
SB-8-0.5	02/01/2007	Discrete	0.5	13.9 U	27.8 U
SB-9-0.5	02/01/2007	Discrete	0.5	13.9 U	37.6
SB-10-0.5	02/01/2007	Discrete	0.5	19.8	221
SB-16-0.5	03/06/2007	Discrete	0.5	59.9	378
SB-17-0.5	03/06/2007	Discrete	0.5	14 U	28 U
SB-23-0.5	03/06/2007	Discrete	0.5	91.3	569

Notes:

1. bgs = Below ground surface.
2. HCID = Hydrocarbon Identification method.
3. -- = Not analyzed.
4. J = The result is an estimated value.
5. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
6. D = Dilution.
7. PHSS CULs = Portland Harbor Superfund Site Cleanup Values, Portland Harbor Record of Decision, Table 17 (Errata #2, January 2020 update), EPA, 2017.
8. JSCS Screening Level Value from Joint Source Control Strategy, DEQ/EPA, 2005.
9. Shaded values represent detected analyte concentrations exceeding CUL or JSCS SLV if there is no riverbank CUL.
10. ROD RAL = Remedial Action Levels from the Portland Harbor Superfund Site ROD (2017).
11. ESD RAL = Remedial Action Levels from the Portland Harbor Superfund Site Explanation of Significant Differences (ESD
12. PTW = Principal Threat Waste threshold from the Portland Harbor Superfund Site ROD (2017).

Table B-3
Historical Riverbank Soil Sampling Results - Volatile Organic Compounds
Terminal 4, Port of Portland
Portland, Oregon

Sample ID Date Location Sample Type Depth (feet bgs)	ROD RAL	ESD RAL	PTW	PHSS CUL	JSCS SLV	T4S1S-23D 09/12/2005 Slip 1 Discrete 0 - 1
Concentration in micrograms per kilogram (µg/kg)						
Benzene	--	--	--	--	--	106 U
Toluene	--	--	--	--	--	106 U
Ethylbenzene	--	--	--	--	--	106 U
Total Xylenes	--	--	--	--	--	--
m,p-Xylenes	--	--	--	--	--	212 U, D
o-Xylene	--	--	--	--	--	106 U
Acetone	--	--	--	--	--	2,650 U
Carbon Disulfide	--	--	--	--	--	1,060 U
Methylene Chloride	--	--	--	--	--	529 U, D
2-Butanone	--	--	--	--	--	1,060 U
Chloroform	--	--	--	--	--	106 U
Carbon Tetrachloride	--	--	--	--	--	106 U
Trichloroethene	--	--	--	--	--	106 U
Tetrachloroethene	--	--	--	--	--	106 U
Chlorobenzene	--	--	320	--	--	106 U
Isopropylbenzene	--	--	--	--	--	212 U
n-Propylbenzene	--	--	--	--	--	106 U
1,2,3-Trichlorobenzene	--	--	--	--	--	83.6 J, D
1,3,5-Trimethylbenzene	--	--	--	--	--	106 U
1,2,4-Trimethylbenzene	--	--	--	--	--	106 U
sec-Butylbenzene	--	--	--	--	--	22.2 J, D
4-Isopropyltoluene	--	--	--	--	--	21.2 J, D
1,4-Dichlorobenzene	--	--	--	--	300	106 U
n-Butylbenzene	--	--	--	--	--	43.4 J, D
Hexachlorobutadiene	--	--	--	--	600	226 J, D
Naphthalene	--	--	140,000	--	561	212 U

Notes:

1. bgs = Below ground surface.
2. -- = Not analyzed or not available
3. J = The result is an estimated value.
4. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
5. D = Dilution.
6. PHSS CULs = Portland Harbor Superfund Site Cleanup Values for Riverbank Soil/Sediment, Portland Harbor Record of Decision, Table 17 (Errata #2, January 2020 update), EPA, 2017.
7. JSCS SLV = Screening Level Value from Joint Source Control Strategy, DEQ/EPA, 2005.
8. Shaded values represent detected analyte concentrations exceeding CUL or JSCS SLV if there is no riverbank CUL.
9. ROD RAL = Remedial Action Levels from the Portland Harbor Superfund Site ROD (2017).
10. ESD RAL = Remedial Action Levels from the Portland Harbor Superfund Site Explanation of Significant Differences (ESD, 2019).
11. PTW = Principal Threat Waste threshold from the Portland Harbor Superfund Site ROD (2017).

Table B-4
Historical Riverbank Soil Sampling Results - Slip 1 Semi-Volatile Organic Compounds
Terminal 4, Port of Portland
Portland, Oregon

Sample ID: Depth (feet bgs): Sample Type: Date Sampled:	ROD RAL	ESD RAL	PTW	PHSS CUL	JSCS SLV	T4S1S-23 0 - 1 Composite 9/12/2005	T4S1S-24 0 - 1 Composite 9/12/2005	T4S1S-25 0 - 1 Composite 9/12/2005	T4S1S-26 0 - 1 Composite 9/13/2005	T4S1S-27 0 - 1 Composite 9/13/2005	T4S1S-28 0 - 1 Composite 9/13/2005	T4S1S-29 0 - 1 Composite 9/13/2005	T4S1S-30 0 - 1 Composite 9/13/2005
Concentration in micrograms per kilogram (µg/kg)													
Slip 1													
Di-n-butyl Phthalate	--	--	--	--	--	14.2 U	14.4 U	15.9 U	27.9 U	27 U	27.2 U	54.8 U	27.7 U
Bis(2-ethylhexyl)phthalate	--	--	--	135	--	14.2 U	14.4 U	17.6 D	27.9 U	27 U	27.2 U	54.8 U	27.7 U

Notes:

1. -- = Not available.
2. J = The result is an estimated value
3. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
4. bgs = Below ground surface.
5. PHSS CULs = Portland Harbor Superfund Site Cleanup Values for Riverbank Soil/Sediment, Portland Harbor Record of Decision, Table 17 (Errata #2, January 2020 update), EPA, 2017.
6. JSCS SLV = Screening Level Value from Joint Source Control Strategy, DEQ/EPA, 2005.
7. Shaded values represent detected analyte concentrations exceeding CUL or JSCS SLV if there is no riverbank CUL.
8. ROD RAL = Remedial Action Levels from the Portland Harbor Superfund Site ROD (2017).
9. ESD RAL = Remedial Action Levels from the Portland Harbor Superfund Site Explanation of Significant Differences (ESD, 2019).
10. PTW = Principal Threat Waste threshold from the Portland Harbor Superfund Site ROD (2017).

Table B-5
Historical Riverbank Soil Sampling Results - Slip 1 Polychlorinated Biphenyls
Terminal 4, Port of Portland
Portland, Oregon

Sample ID: Depth (feet bgs): Sample Type: Date Sampled:	ROD RAL	ESD RAL	PTW	PHSS CUL	JSCS SLV	T4S1S-23 0 - 1 Composite 9/12/2005	T4S1S-24 0 - 1 Composite 9/12/2005	T4S1S-25 0 - 1 Composite 9/12/2005	T4S1S-26 0 - 1 Composite 9/13/2005	T4S1S-27 0 - 1 Composite 9/13/2005	T4S1S-28 0 - 1 Composite 9/13/2005	T4S1S-29 0 - 1 Composite 9/13/2005	T4S1S-30 0 - 1 Composite 9/13/2005
						Concentration in milligrams per kilogram (mg/kg)							
Slip 1													
Aroclor 1254	--	--	--	--	0.3	0.0355 U	0.0359 U	0.0394 U	0.0516 U	0.0335 U	0.0335 U	0.0845 U	0.0343 U
Aroclor 1260	--	--	--	--	0.2	0.0355 U	0.0359 U	0.0394 U	0.0344 U	0.0335 U	0.0335 U	0.0338 U	0.0343 U
Aroclor 1262	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1268	--	--	--	--	--	--	--	--	--	--	--	--	--
Total PCBs	0.075	--	0.2	0.009	--	0.0355 U	0.0359 U	0.0394 U	0.0516 U	0.0335 U	0.0335 U	0.0845 U	0.0343 U

Notes:

1. -- = Not analyzed.
2. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
3. bgs = Below ground surface.
4. PHSS CULs = Portland Harbor Superfund Site Cleanup Values for Riverbank Soil/Sediment, Portland Harbor Record of Decision, Table 17 (Errata #2, January 2020 update), EPA, 2017.
5. JSCS SLV = Screening Level Value from Joint Source Control Strategy, DEQ/EPA, 2005.
6. T = Result calculated or selected from >1 reported value.
7. Shaded values represent detected analyte concentrations exceeding CUL or JSCS SLV if there is no riverbank CUL.
8. ROD RAL = Remedial Action Levels from the Portland Harbor Superfund Site ROD (2017).
9. ESD RAL = Remedial Action Levels from the Portland Harbor Superfund Site Explanation of Significant Differences (ESD, 2019).
10. PTW = Principal Threat Waste threshold from the Portland Harbor Superfund Site ROD (2017).

Table B-6
Historical Riverbank Soil Sampling Results - Slip 1 Pesticides
Terminal 4, Port of Portland
Portland, Oregon

Sample ID:	ROD RAL	ESD RAL	PTW	PHSS CUL	JSCS SLV	T4S1S-23	T4S1S-23A	T4S1S-23B	T4S1S-23C	T4S1S-23D	T4S1S-24	T4S1S-24A	T4S1S-24B	T4S1S-24C	T4S1S-24D	T4S1S-25	T4S1S-25A
Depth (feet bgs):						0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Sample Type:						Composite	Discrete	Discrete	Discrete	Discrete	Composite	Discrete	Discrete	Discrete	Discrete	Composite	Discrete
Date Sampled:						9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005
Concentration in micrograms per kilogram (µg/kg)																	
Slip 1																	
delta-BHC	--	--	--	--	--	1.06 UD	7.22 U	1.44 U	1.43 U	1.44 U	1.09 UD	1.45 U	1.48 U	1.46 U	1.40 U	1.07 UD	1.49 U
Heptachlor	--	--	--	--	10	1.06 UD	7.22 U	1.44 U	1.43 U	1.44 U	1.09 UD	1.45 U	1.48 U	1.46 U	1.40 U	1.07 UD	1.49 U
Heptachlor Epoxide	--	--	--	--	16	1.06 UD	7.22 U	1.44 U	1.43 U	1.44 U	1.09 UD	1.45 U	1.48 U	1.46 U	1.40 U	1.07 UD	1.49 U
Aldrin	--	--	--	2	--	1.06 UD	7.22 U	1.44 U	1.43 U	1.44 U	1.09 UD	1.45 U	1.48 U	1.46 U	1.40 U	1.07 UD	1.49 U
gamma-Chlordane	--	--	--	--	--	1.06 UD	7.22 U	1.44 U	1.43 U	1.44 U	1.09 UD	1.45 U	1.48 U	1.46 U	1.40 U	1.07 UD	1.49 U
Endosulfan I	--	--	--	--	--	0.329 UD	7.22 U	1.44 U	1.43 U	1.44 U	1.09 UD	1.45 U	1.48 U	1.46 U	1.40 U	1.07 UD	1.49 U
alpha-Chlordane	--	--	--	--	--	1.06 UD	7.22 U	1.44 U	1.43 U	1.44 U	1.09 UD	1.45 U	1.48 U	1.46 U	1.40 U	1.07 UD	1.49 U
Dieldrin	--	--	--	0.07	--	2.13 UD	7.22 U	1.44 U	1.43 U	1.44 U	2.17 UD	1.45 U	1.48 U	1.46 U	1.40 U	2.14 UD	1.49 U
4,4'-DDD	--	--	--	114	--	2.13 UD	7.22 U	1.44 U	1.43 U	1.44 U	2.17 UD	1.45 U	1.48 U	1.46 U	1.40 U	2.14 UD	1.49 U
4,4'-DDE	--	--	--	50	--	2.13 UD	7.22 U	1.44 U	1.43 U	1.44 U	2.17 UD	1.45 U	1.48 U	1.46 U	1.40 U	2.14 UD	1.49 U
4,4'-DDT	--	--	--	246	--	0.700 JD	7.22 U	1.44 UD	1.43 UD	1.44 U	0.434 JD	1.45 U	1.48 UD	1.46 UD	1.40 U	0.511 JD	1.49 UD
DDx	160	--	7,050	6.1	--	2.830 T	10.83 UT	2.16 UT	2.145 UT	2.16 UT	2.604 T	2.175 UT	2.22 UT	2.19 UT	2.10 UT	2.651 T	2.235 UT
Endrin	--	--	--	--	207	2.130 UD	7.22 U	1.44 U	1.43 U	1.44 U	2.17 UD	1.45 U	1.48 U	1.46 U	1.40 U	2.14 UD	1.49 U
Endrin Aldehyde	--	--	--	--	--	2.13 UD	7.22 U	1.44 U	1.43 U	1.44 U	2.17 UD	1.45 U	1.48 U	1.46 U	1.40 U	2.14 UD	1.49 U
Endrin Ketone	--	--	--	--	--	2.13 UD	7.22 U	1.44 U	1.43 U	1.44 U	2.17 UD	1.45 U	1.48 U	1.46 U	1.40 U	2.14 UD	1.49 U
Methoxychlor	--	--	--	--	--	2.13 UD	7.22 U	1.44 UD	1.43 U	1.44 U	2.17 UD	1.45 U	1.48 U	1.46 U	1.40 U	2.14 UD	1.49 U

Please see notes at end ot table.

Table B-6
Historical Riverbank Soil Sampling Results - Slip 1 Pesticides
Terminal 4, Port of Portland
Portland, Oregon

Sample ID: / Depth (feet bgs): / Sample Type: / Date Sampled:	ROD RAL	ESD RAL	PTW	PHSS CUL	JSCS SLV	T4S1S-25B 0 - 1 Discrete 9/12/2005	T4S1S-25C 0 - 1 Discrete 9/12/2005	T4S1S-25D 0 - 1 Discrete 9/12/2005	T4S1S-26 0 - 1 Composite 9/13/2005	T4S1S-26A 0 - 1 Discrete 9/13/2005	T4S1S-26B 0 - 1 Discrete 9/13/2005	T4S1S-26C 0 - 1 Discrete 9/13/2005	T4S1S-26D 0 - 1 Discrete 9/13/2005	T4S1S-27 0 - 1 Composite 9/13/2005	T4S1S-27A 0 - 1 Discrete 9/13/2005	T4S1S-27B 0 - 1 Discrete 9/13/2005	T4S1S-27C 0 - 1 Discrete 9/13/2005
Concentration in micrograms per kilogram (µg/kg)																	
Slip 1																	
delta-BHC	--	--	--	--	--	1.39 U	1.42 U	1.39 U	1.04 UD	1.37 U	6.87 U	1.39 U	7.70 U	1.02 UD	6.78 U	1.35 U	1.37 U
Heptachlor	--	--	--	--	10	1.39 U	1.42 U	1.39 U	1.04 UD	1.37 U	6.87 U	1.39 U	7.70 U	1.02 UD	6.78 U	1.35 U	1.37 U
Heptachlor Epoxide	--	--	--	--	16	1.39 U	1.42 U	1.39 U	1.04 UD	1.37 U	6.87 U	1.39 U	7.70 U	1.02 UD	6.78 U	1.35 U	1.37 U
Aldrin	--	--	--	2	--	1.39 U	1.42 U	1.39 U	1.04 UD	1.37 U	6.87 U	1.39 U	7.70 U	1.02 UD	6.78 U	1.35 U	1.37 U
gamma-Chlordane	--	--	--	--	--	1.39 U	1.42 U	1.39 U	1.04 UD	1.37 U	6.87 U	1.39 U	7.70 U	1.02 UD	6.78 U	1.35 U	1.37 U
Endosulfan I	--	--	--	--	--	1.39 U	1.42 U	1.39 U	1.04 UD	1.37 U	6.87 U	1.39 U	7.70 U	1.02 UD	6.78 U	1.35 U	1.37 U
alpha-Chlordane	--	--	--	--	--	1.39 U	1.42 U	1.39 U	1.04 UD	1.37 U	6.87 U	1.39 U	77.0 U	1.02 UD	67.8 U	1.35 U	1.37 U
Dieldrin	--	--	--	0.07	--	1.39 U	1.42 U	1.39 U	0.761 JD	1.37 U	68.7 U	1.39 U	77.0 U	2.04 UD	67.8 U	1.35 U	1.37 U
4,4'-DDD	--	--	--	114	--	1.39 U	1.42 U	1.39 U	2.37 D	1.37 U	6.87 U	1.39 U	7.70 U	2.04 UD	6.78 U	1.35 U	0.873 JD
4,4'-DDE	--	--	--	50	--	1.39 U	1.42 U	1.39 U	5.22 D	1.37 U	68.7 U	1.39 U	77.0 U	1.83 JD	6.78 U	1.35 U	1.37 U
4,4'-DDT	--	--	--	246	--	1.39 UD	1.42 UD	1.39 U	17.2 D	1.37 UD	6.87 U	1.11 JD	96.8 D	3.66 D	67.8 U	1.35 UD	1.37 UD
DDx	160	--	7,050	6.1	--	2.085 UT	2.13 UT	2.085 UT	24.79 T	2.055 UT	41.22 UT	2.5 T	139.15 T	6.51 T	40.68 UT	2.025 UT	2.243 T
Endrin	--	--	--	--	207	1.39 U	1.42 U	1.39 U	2.09 UD	1.37 U	6.87 U	1.39 U	7.7 U	2.04 UD	67.8 U	1.35 U	1.37 U
Endrin Aldehyde	--	--	--	--	--	1.39 U	1.42 U	1.39 U	2.09 UD	1.37 U	6.87 U	1.39 U	77.0 U	2.04 UD	67.8 U	1.35 U	1.37 U
Endrin Ketone	--	--	--	--	--	1.39 U	1.42 U	1.39 U	2.09 UD	1.37 U	6.87 U	1.39 U	77.0 U	2.04 UD	67.8 U	1.35 U	1.37 U
Methoxychlor	--	--	--	--	--	1.39 U	1.42 U	1.39 U	2.09 UD	1.37 U	68.7 U	1.39 U	77.0 U	2.04 UD	67.8 U	1.35 U	1.37 U

Please see notes at end ot table.

Table B-6
Historical Riverbank Soil Sampling Results - Slip 1 Pesticides
Terminal 4, Port of Portland
Portland, Oregon

Sample ID: / Depth (feet bgs): / Sample Type: / Date Sampled:	ROD RAL	ESD RAL	PTW	PHSS CUL	JSCS SLV	T4S1S-27D 0 - 1 Discrete 9/13/2005	T4S1S-28 0 - 1 Composite 9/13/2005	T4S1S-28A 0 - 1 Discrete 9/13/2005	T4S1S-28B 0 - 1 Discrete 9/13/2005	T4S1S-28C 0 - 1 Discrete 9/13/2005	T4S1S-28D 0 - 1 Discrete 9/13/2005	T4S1S-29 0 - 1 Composite 9/13/2005	T4S1S-30 0 - 1 Composite 9/13/2005	T4S1S-30A 0 - 1 Discrete 9/13/2005	T4S1S-30C 0 - 1 Discrete 9/13/2005	T4S1S-30D 0 - 1 Discrete 9/13/2005
Concentration in micrograms per kilogram (µg/kg)																
Slip 1																
delta-BHC	--	--	--	--	--	1.37 U	1.01 UD	1.03 U	1.02 U	1.02 U	1.01 U	1.03 UD	1.03 UD	1.03 U	1.01 U	1.04 U
Heptachlor	--	--	--	--	10	1.37 U	1.01 UD	1.03 U	1.02 U	1.02 U	1.01 U	1.03 UD	1.03 UD	1.03 U	1.01 U	1.04 U
Heptachlor Epoxide	--	--	--	--	16	1.37 U	1.01 UD	1.03 U	1.02 U	1.02 U	1.01 U	1.03 UD	0.190 JD	1.03 U	1.01 U	1.04 U
Aldrin	--	--	--	2	--	1.37 U	1.01 UD	1.03 U	1.02 U	1.02 U	1.01 U	1.03 UD	1.03 UD	1.03 U	1.01 U	1.04 U
gamma-Chlordane	--	--	--	--	--	1.37 U	1.01 UD	1.03 U	1.02 U	1.02 U	1.01 U	1.03 UD	1.03 UD	1.03 U	1.01 U	1.04 U
Endosulfan I	--	--	--	--	--	1.37 U	1.01 UD	1.03 U	1.02 U	1.02 U	1.01 U	1.03 UD	1.03 UD	1.03 U	1.01 U	1.04 U
alpha-Chlordane	--	--	--	--	--	1.37 U	1.01 UD	1.03 U	1.02 U	1.02 U	1.01 U	1.03 UD	1.03 UD	1.03 U	1.01 U	1.04 U
Dieldrin	--	--	--	0.07	--	1.37 U	2.03 UD	2.06 U	0.274 J	2.05 U	0.808 J	2.06 UD	0.397 JD	0.896 J	2.02 U	0.381 J
4,4'-DDD	--	--	--	114	--	1.37 U	2.03 UD	2.06 U	2.04 U	2.05 U	0.654 J	2.79 D	2.05 UD	2.06 U	2.02 U	2.07 U
4,4'-DDE	--	--	--	50	--	1.37 U	1.72 JD	2.06 U	2.04 U	2.05 U	1.61 J	7.84 D	2.05 UD	2.06 U	2.02 U	2.07 U
4,4'-DDT	--	--	--	246	--	1.37 UD	3.43 D	3.72	0.648 J	0.925 J	4.66	15.9 D	1.66 JD	2.50	1.54 J	1.35 J
DDx	160	--	7,050	6.1	--	2.055 UT	6.165 T	5.78 T	2.688 T	2.975 T	6.924 T	26.53 T	3.71 T	4.56 T	3.56 T	3.42 T
Endrin	--	--	--	--	207	1.37 U	2.03 UD	2.06 U	2.04 U	2.05 U	2.01 U	2.06 UD	2.05 UD	2.06 U	2.02 U	2.07 U
Endrin Aldehyde	--	--	--	--	--	1.37 U	2.03 UD	2.06 U	2.04 U	2.05 U	2.01 U	2.06 UD	2.05 UD	2.06 U	2.02 U	2.07 U
Endrin Ketone	--	--	--	--	--	1.37 U	2.03 UD	2.06 U	2.04 U	2.05 U	2.01 U	2.06 UD	2.05 UD	2.06 U	2.02 U	2.07 U
Methoxychlor	--	--	--	--	--	1.37 U	2.03 UD	2.06 U	2.04 U	2.05 U	2.01 U	2.06 UD	2.05 UD	2.06 U	2.02 U	2.07 U

Please see notes at end ot table.

Table B-6
Historical Riverbank Soil Sampling Results - Slip 1 Pesticides
Terminal 4, Port of Portland
Portland, Oregon

Sample ID: Depth (feet bgs): Sample Type: Date Sampled:	ROD RAL	ESD RAL	PTW	PHSS CUL	JSCS SLV	S-37 0-1 Composite 8/26/2008	S-38 0-1 Composite 10/4/2008	S-39 0-1 Composite 9/12/2008	S-40 0-1 Composite 9/12/2008	S-41 0-1 Composite 9/4/2008
Slip 1										
delta-BHC	--	--	--	--	--	--	--	--	--	--
Heptachlor	--	--	--	--	10	--	--	--	--	--
Heptachlor Epoxide	--	--	--	--	16	--	--	--	--	--
Aldrin	--	--	--	2	--	--	--	--	--	--
gamma-Chlordane	--	--	--	--	--	--	--	--	--	--
Endosulfan I	--	--	--	--	--	--	--	--	--	--
alpha-Chlordane	--	--	--	--	--	--	--	--	--	--
Dieldrin	--	--	--	0.07	--	--	--	--	--	--
4,4'-DDD	--	--	--	114	--	--	--	--	--	--
4,4'-DDE	--	--	--	50	--	--	--	--	--	--
4,4'-DDT	--	--	--	246	--	101	7.61 U	8.65 U	12.3	20.4
DDx	160	--	7,050	6.1	--	--	--	--	--	--
Endrin	--	--	--	--	207	--	--	--	--	--
Endrin Aldehyde	--	--	--	--	--	--	--	--	--	--
Endrin Ketone	--	--	--	--	--	--	--	--	--	--
Methoxychlor	--	--	--	--	--	--	--	--	--	--

Notes:

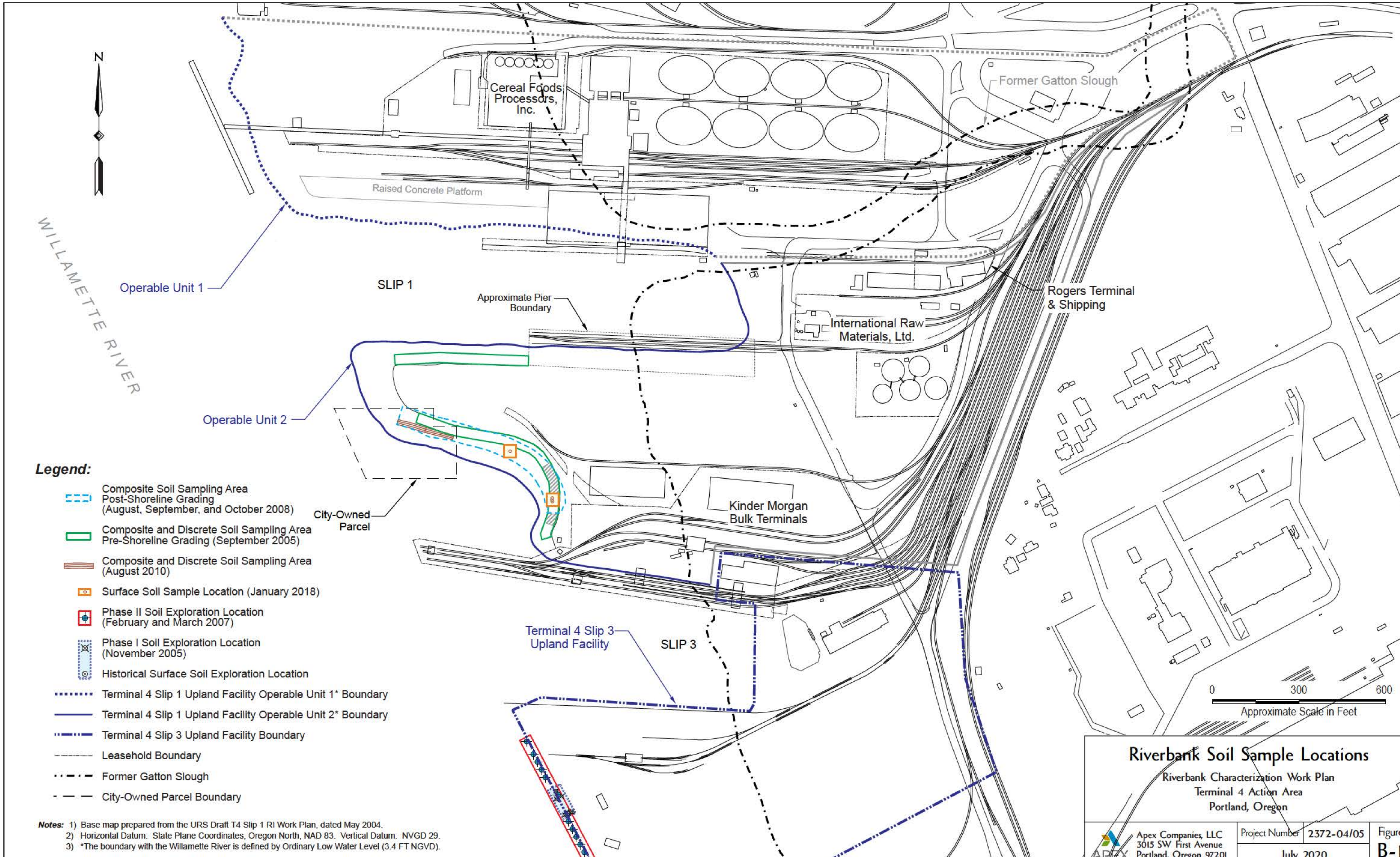
1. J = The result is an estimated concentration that is less than the method reporting limit (MRL) but greater than or equal to the method detection limit (MDL).
2. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
3. bgs = Below ground surface.
4. PHSS CULs = Portland Harbor Superfund Site Cleanup Values for Riverbank Soil/Sediment, Portland Harbor Record of Decision, Table 17 (Errata #2, January 2020 update), EPA, 2017.
5. JSCS SLV = Screening Level Value from Joint Source Control Strategy, DEQ/EPA, 2005.
6. T = Result calculated or selected from >1 reported value.
7. Total values calcaulated according to Appendix A of the Portland Harbor RI/FS, June 2016
8. Shaded values represent detected analyte concentrations exceeding CUL or JSCS SLV if there is no riverbank CUL.
9. ROD RAL = Remedial Action Levels from the Portland Harbor Superfund Site ROD (2017).
10. ESD RAL = Remedial Action Levels from the Portland Harbor Superfund Site Explanation of Significant Differences (ESD, 2019).
11. PTW = Principal Threat Waste threshold from the Portland Harbor Superfund Site ROD (2017).

Table B-7
Historical Riverbank Soil Sampling Results - Slip 1 Metals
Terminal 4, Port of Portland
Portland, Oregon

Sample ID:	ROD RAL	ESD RAL	PTW	PHSS CUL	JSCS SLV	T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-26A	T4S1S-26B	T4S1S-26C	T4S1S-26D	T4S1S-27	T4S1S-28	T4S1S-29	T4S1S-30	S-37	S-38	S-39	S-40	S-41	S-42	S-42A	S-42B	S-45
Sample Interval:						0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0-1	0-1	0-1	0-1	0-1	0-0.3	0-0.3	0-0.3	0-0.3
Sample Type:						Composite	Composite	Composite	Composite	Discrete	Discrete	Discrete	Discrete	Composite	Discrete	Composite	Composite	Composite	Composite	Discrete	Discrete	Composite	Composite	Discrete	Discrete	Composite
Date Sampled:						9/12/2005	9/12/2005	9/12/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	8/26/2008	10/4/2008	9/12/2008	9/12/2008	9/4/2008	8/27/2010	8/27/2010	8/27/2010	8/27/2010
Concentration in milligrams per kilogram (mg/kg)																										
Slip 1																										
Antimony	--	--	--	--	64	1.48 U, D	1.58 U, D	1 59 U	0.0728 J	1.53 U	1 53 U	1.54 U	1.74 U	1.53 U	1.53 U	1 51 U, D	1.53 U, D	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	3	--	2.81 D	3.08 D	2.69	10 9	2.49	2 23	2.97	15.7	2.59	3.72	14 5 D	2.47 D	8.83	4.44	3.95	5.02	4.78	--	--	--	--
Beryllium	--	--	--	--	--	0.326 J, D	0.321 J, D	0 296 J	0.26 J	0 209 J	0.285 J	0.277 J	0.186 J	0.295 J	0 316 J	0.292 J, D	0.352 J, D	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	0 51	--	0.158 J, D	0.11 J, D	0.122 J	7.02	0.22 J	0 27 J	0.646	25.3	0.402 J	0.815	2.12 D	0.352 J, D	1.86	0.545 U	0.637 U	0.742	0.998	--	--	--	--
Chromium	--	--	--	--	111	13.4 D	14.8 D	13.9	16.4	12.3	14 5	15 2	23.6	16	16.6	23.8 D	16.8 D	--	--	--	--	--	--	--	--	--
Copper	--	--	--	359	--	13 5 D	13.7 D	14.1	78.1	12	14	16 9	219 D	16.7	19.5	38 5 D	17 D	34.4	17 3	15.5	17.7	24 9	--	--	--	--
Lead	--	--	--	196	--	6 24 D	4.59 D	5.07	479 D	7.78	12.6	43.6	868 D	30.4	88.8	276 D	41.8 D	427	32.8	54.7	118	117	17	38	8.5	3 2
Mercury	--	--	--	0.085	--	0.0954 U, D	0.0092 J, D	0.0108 J, D	0.0947 J	0.126 U, D	0.131 U, D	0.13 U, D	0 325 D	0.102 U	0.0261 J, D	0.0799 J, D	0.034 J, D	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	48.6	16.7 D	18 D	19.2	18.4	16.2	16.6	17 5	19.3	19 5	19	17.7 D	20 5 D	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	5	0.252 J, D	0.479 J, D	0 338 J	0.286 J	0.184 J	0.163 J	0.159 J	0.407 J	0.229 J	0 295 J	0.347 J, D	0.25 J, D	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	5	0.495 U, D	0.526 U, D	0 529 U	1.16	0 511 U	0.509 U	0.123 J	2.1	0.509 U	0.0967 J	0.66 D	0.51 U, D	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	0.495 U, D	0.526 U, D	0 529 U	0.0624 J	0 511 U	0.509 U	0.513 U	0.122 J	0.509 U	0 509 U	0.504 U, D	0.51 U, D	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	459	--	52.6 D	52 9 D	55.9	949 D	55.7	64	127	3320 D	112	181	328 D	91.4 D	323	93.7	90.8	163	190	--	--	--	--

Notes:

1. -- = No screening level available or not analyzed.
2. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
3. bgs = Below ground surface.
4. J = The result is an estimated value.
5. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
6. D = Dilution.
7. Shaded values represents detected analyte concentrations exceeding the CUL or JSCS SLV if there is no riverbank CUL.
8. PHSS CULs = Portland Harbor Superfund Site Cleanup Values for Riverbank Soil/Sediment, Portland Harbor Record of Decision, Table 17 (Errata #2, January 2020 update), EPA, 2017.
9. JSCS SLV = Screening Level Value from Joint Source Control Strategy, DEQ/EPA, 2005
10. ROD RAL = Remedial Action Levels from the Portland Harbor Superfund Site ROD (2017).
11. ESD RAL = Remedial Action Levels from the Portland Harbor Superfund Site Explanation of Significant Differences (ESD, 2019).
12. PTW = Principal Threat Waste threshold from the Portland Harbor Superfund Site ROD (2017).

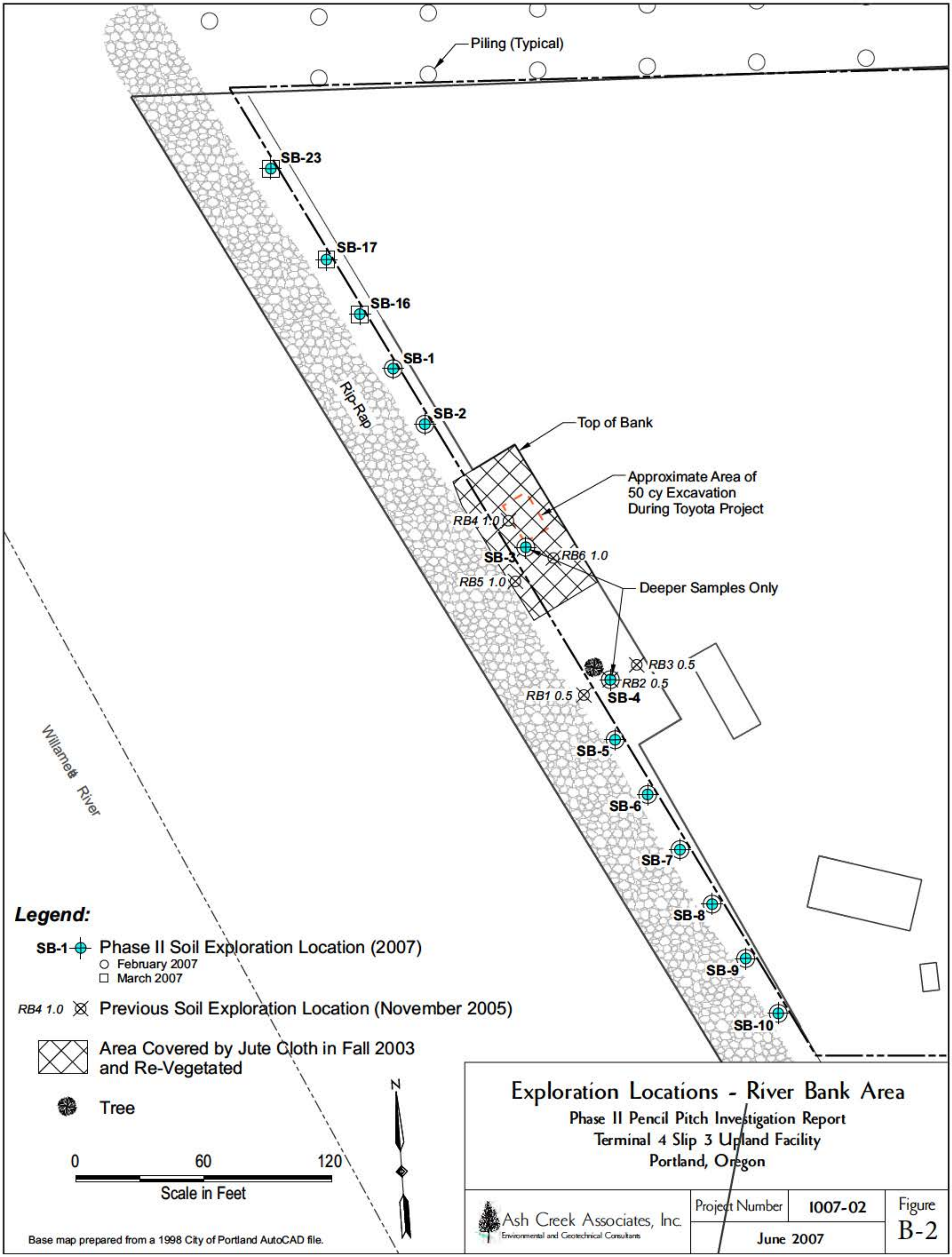


Notes: 1) Base map prepared from the URS Draft T4 Slip 1 RI Work Plan, dated May 2004.
2) Horizontal Datum: State Plane Coordinates, Oregon North, NAD 83. Vertical Datum: NVGD 29.
3) *The boundary with the Willamette River is defined by Ordinary Low Water Level (3.4 FT NGVD).

Riverbank Soil Sample Locations

Riverbank Characterization Work Plan
Terminal 4 Action Area
Portland, Oregon

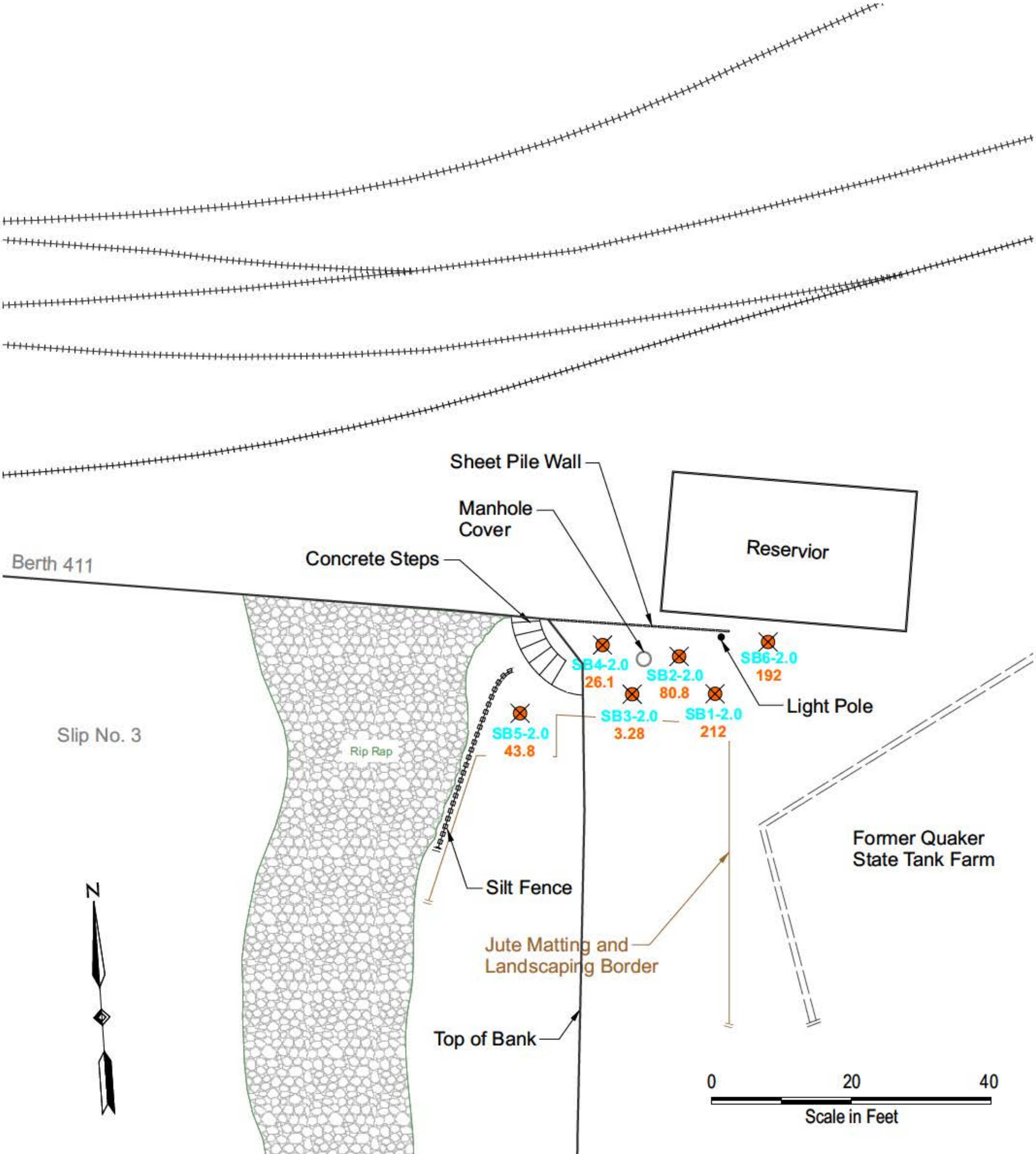
Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number 2372-04/05 July 2020	Figure B-1



Exploration Locations - River Bank Area

Phase II Pencil Pitch Investigation Report
Terminal 4 Slip 3 Upland Facility
Portland, Oregon

Ash Creek Associates, Inc. Environmental and Geotechnical Consultants	Project Number	1007-02	Figure
	June 2007		B-2



Legend:

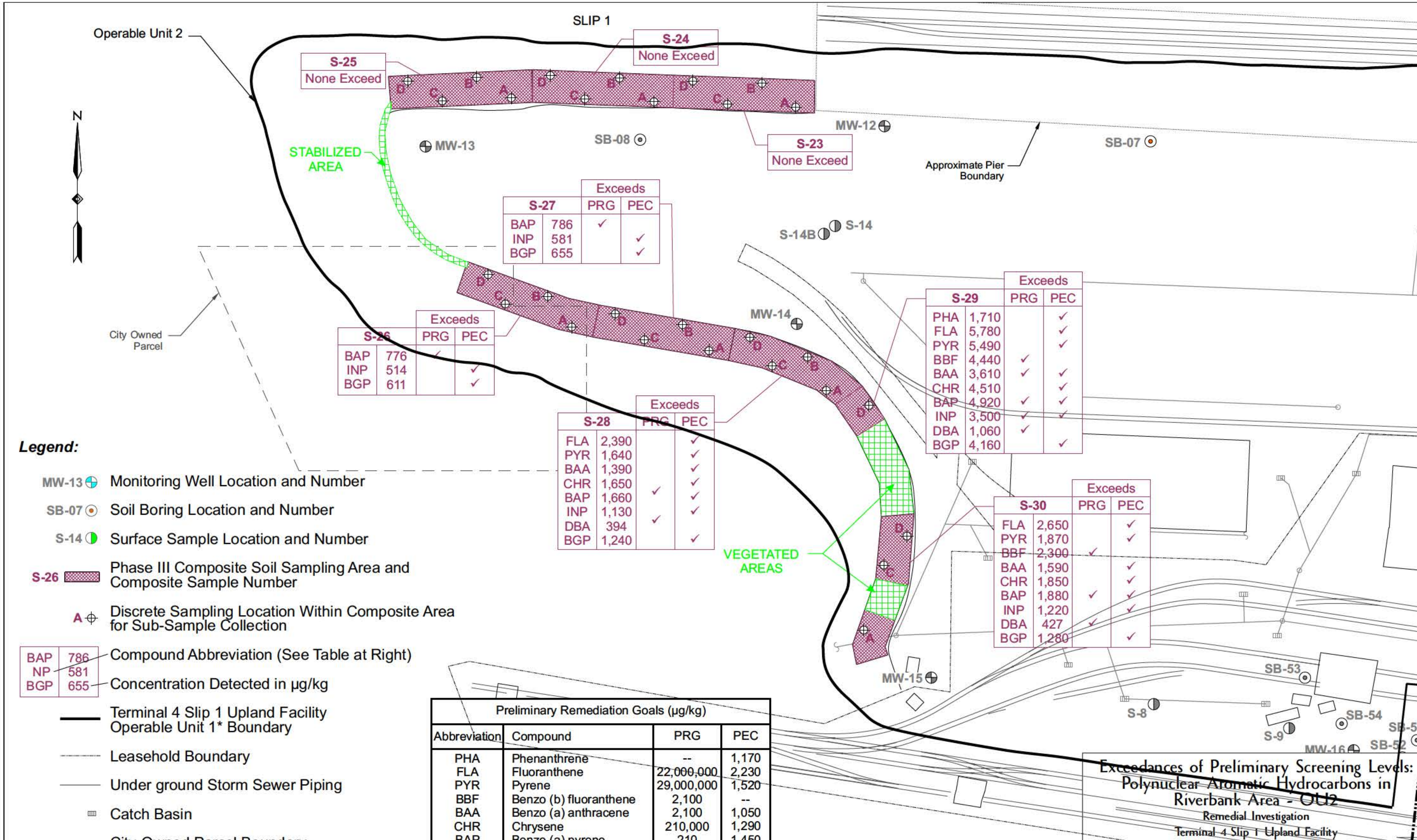
SB1-2.0 212 Approximate Soil Exploration Location, Sample Designation, and Total PAH Concentration in mg/kg

Base map prepared from a 1998 City of Portland AutoCAD file.

Slip Bank Area Explorations

Pencil Pitch Investigation Work Plan
Terminal 4 Slip 3 Upland Facility
Portland, Oregon

Project Number	1007-02	January 2006	Figure
NEWFIELDS	Ash Creek Associates, Inc. Environmental and Geotechnical Consultants	BBL Blasland, Bouck & Lee, Inc. engineers, scientists, economists	B-3



S-26		Exceeds PRG	Exceeds PEC
BAP	776	✓	
INP	514		✓
BGP	611		✓

S-27		Exceeds PRG	Exceeds PEC
BAP	786	✓	
INP	581		✓
BGP	655		✓

S-28		Exceeds PRG	Exceeds PEC
FLA	2,390		✓
PYR	1,640		✓
BAA	1,390		✓
CHR	1,650		✓
BAP	1,660	✓	✓
INP	1,130	✓	✓
DBA	394		
BGP	1,240		✓

S-29		Exceeds PRG	Exceeds PEC
PHA	1,710		✓
FLA	5,780		✓
PYR	5,490		✓
BBF	4,440	✓	
BAA	3,610	✓	✓
CHR	4,510		✓
BAP	4,920	✓	✓
INP	3,500	✓	✓
DBA	1,060	✓	
BGP	4,160		✓

S-30		Exceeds PRG	Exceeds PEC
FLA	2,650		✓
PYR	1,870		✓
BBF	2,300	✓	
BAA	1,590		✓
CHR	1,850		✓
BAP	1,880	✓	✓
INP	1,220		✓
DBA	427	✓	
BGP	1,280		✓

Preliminary Remediation Goals (µg/kg)

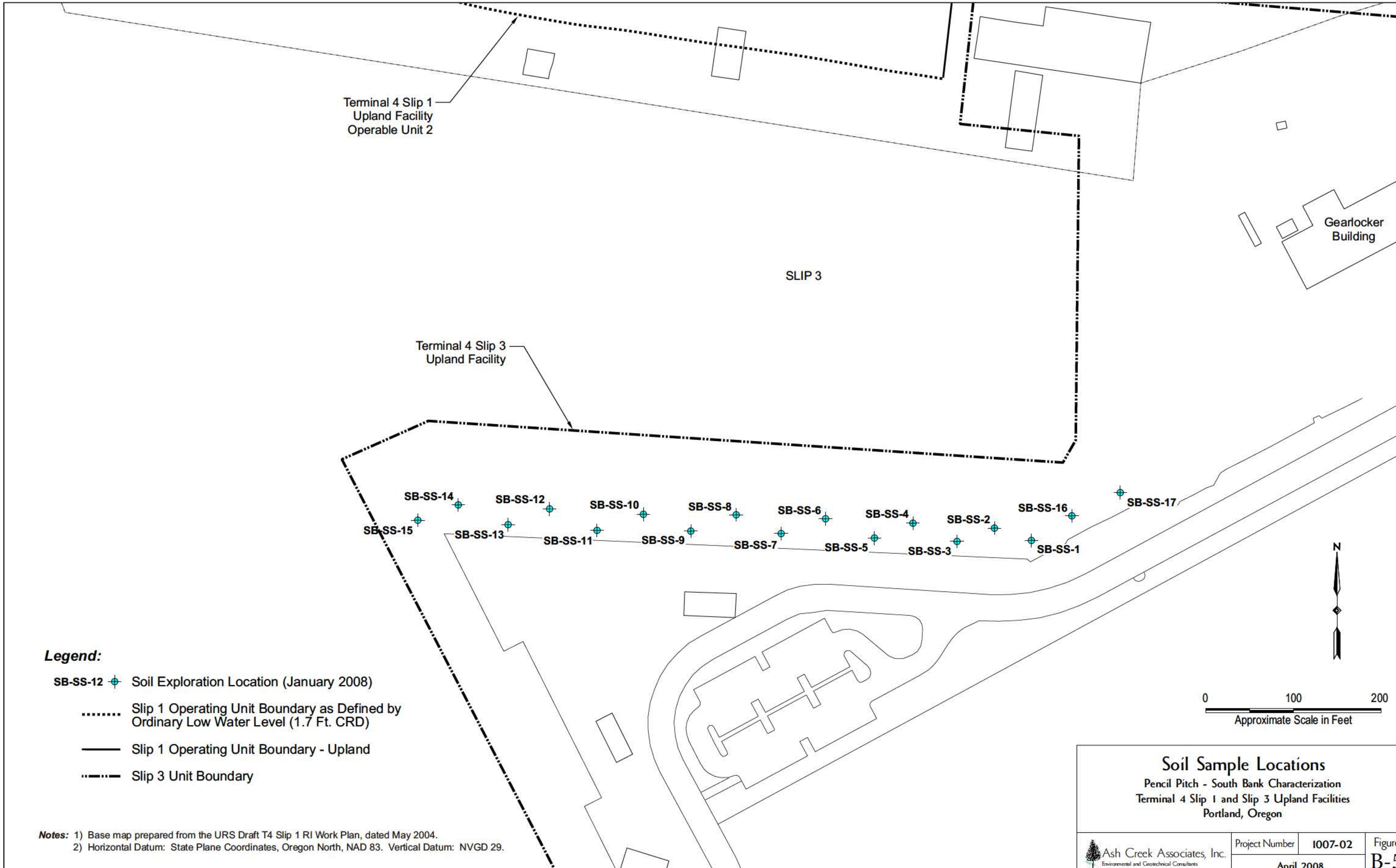
Abbreviation	Compound	PRG	PEC
PHA	Phenanthrene	--	1,170
FLA	Fluoranthene	22,000,000	2,230
PYR	Pyrene	29,000,000	1,520
BBF	Benzo (b) fluoranthene	2,100	--
BAA	Benzo (a) anthracene	2,100	1,050
CHR	Chrysene	210,000	1,290
BAP	Benzo (a) pyrene	210	1,450
INP	Indeno (1,2,3-cd) pyrene	2,100	100
DBA	Dibenzo (a,h) anthracene	210	1,300
BGP	Benzo (g,h,i) perylene	--	300

Notes:
1) Base map prepared from the URS Draft T4 Slip 1 RI Work Plan, dated May 2004.
2) Horizontal Datum: State Plane Coordinates, Oregon North, NAD 83. Vertical Datum: NVGD 29.
3) *The boundary with the Willamette River is defined by Ordinary Low Water Level (3.4 FT NGVD).
4) Prefix "T4S1" removed from sample locations for figure clarity.
5) See Table 7 for Discrete Sample Results.
6) PRG = EPA Region 9 Preliminary Remediation Goal (PRG) for Industrial Soil (EPA, 2004a).
7) PEC = Probable Effect Concentration Obtained From Table 3-1 of the DEQ Joint Source Control Strategy Document.

Exceedances of Preliminary Screening Levels: Polynuclear Aromatic Hydrocarbons in Riverbank Area - OU2

Remedial Investigation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Project Number	1065-00	August 2007	Figure
Ash Creek Associates, Inc. Environmental and Geotechnical Consultants		NEWFIELDS	B-4



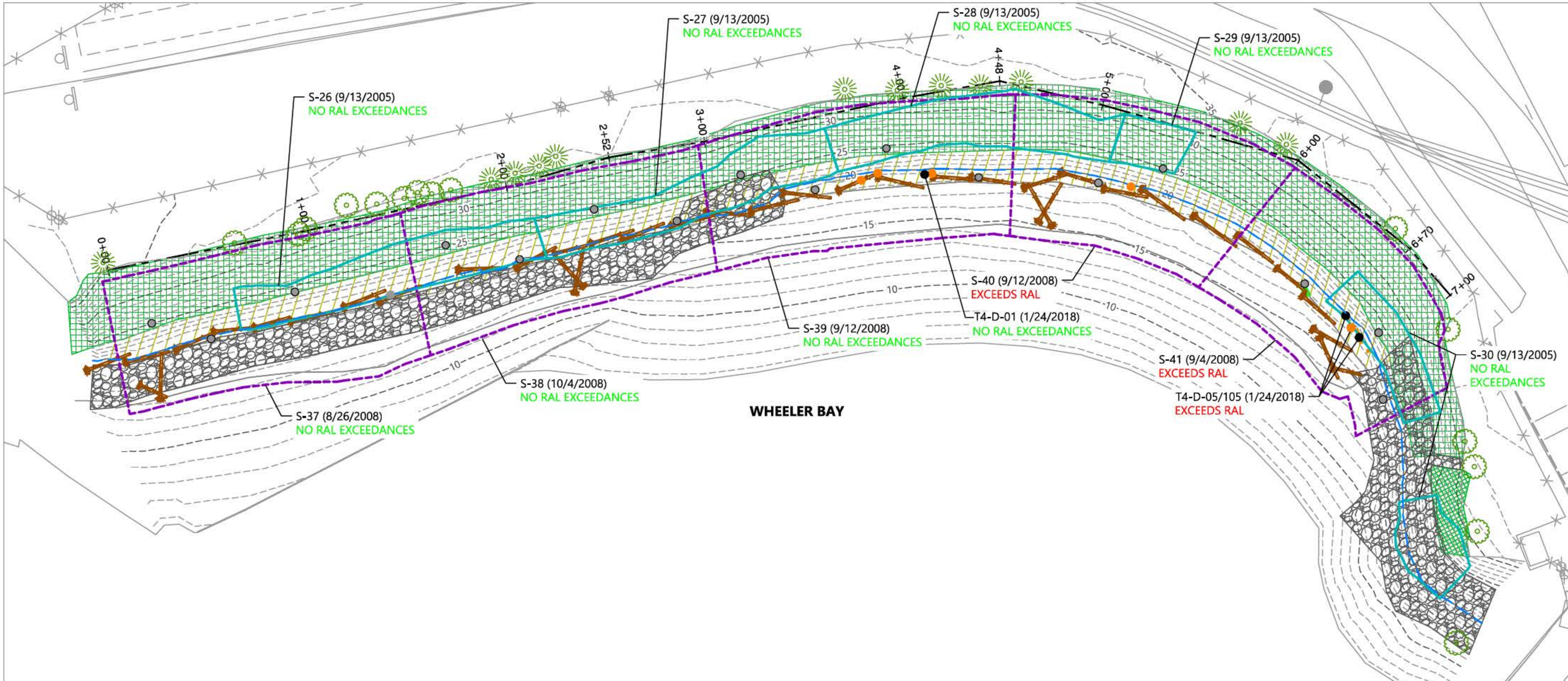
Notes: 1) Base map prepared from the URS Draft T4 Slip 1 RI Work Plan, dated May 2004.
2) Horizontal Datum: State Plane Coordinates, Oregon North, NAD 83. Vertical Datum: NVGD 29.

Soil Sample Locations

Pencil Pitch - South Bank Characterization
Terminal 4 Slip 1 and Slip 3 Upland Facilities
Portland, Oregon

Ash Creek Associates, Inc.
Environmental and Geotechnical Consultants

Project Number 1007-02
April 2008
Figure B-5



NOTES:

1. Horizontal Datum: Port of Portland, Local Projection (International Feet); Vertical Datum: NAVD88
2. Pre-construction survey by Port of Portland dated October 2018.
3. Initial discrete segments of orange construction fencing observed during Year 9 monitoring event in June 2017. Additional segments of discrete orange fencing observed during August 2018 post-high water monitoring survey
4. Samples dated 2008 were 4-point composites collected at a depth of 0-30 centimeters below finish subgrade of the Wheeler Bay Stabilization project. The surface of the subgrade is delineated by a demarcation layer consisting of orange plastic mesh. In general, the depth from finish grade to subgrade is 1 foot for two of the four composite subsamples (i.e., in the hydroseed area) and 2 feet (i.e., in the willow planting area) for the other two composite subsamples.
5. Samples dated 2018 were collected at a depth of 0-30 centimeters below the existing surface when the orange demarcation layer was exposed following a period of high-water conditions.

LEGEND:

- Existing Hydroseeding With Jute Matting
- Existing Willow Planting Zone
- Existing Habitat Material Over Armor Rock
- Existing Armor Rock
- Existing Habitat Log (Anchored)
- October 2018 Contours (1' & 5' Intervals)
- Ordinary High Water (+19.94 NAVD88)
- Existing Deciduous Tree
- Existing Evergreen Tree
- Existing Fence
- Project Station Line
- Exposed Orange Construction Fencing (See Note 3)
- Discrete Exposed Orange Construction Fencing (See Note 3)
- 2008 Samples
- 2008 (Post-Shoreline Grading) Composite Sampling Boundary
- 2005 (Pre-Shoreline Grading) Composite Sampling Boundary
- 2018 Samples

0 50 Feet

Appendix C

Sampling and Analysis Plan/Quality Assurance Project Plan

Riverbank Characterization Work Plan
Sampling and Analysis Plan, Revision 2
Terminal 4 Action Area
Portland, Oregon

Prepared for: Port
of Portland

September 4, 2020
2372-07

Approval Page

U.S. Environmental Protection Agency, Region 10

Josie Clark, Regional Project Manager	*Date*

Port of Portland

Kelly Madalinski, Project Coordinator	*Date*

Apex Companies, LLC

	9/4/2020
Steve Misner, Project Manager	*Date*

Apex Companies, LLC

	9/4/2020
Kelsi Evans, Quality Assurance Manager	*Date*

Distribution List

Recipient	Title/Role	Organization
Josie Clark	Regional Project Manager	U.S. Environmental Protection Agency
Jeff Schatz	Project Manager	Oregon Department of Environmental Quality
Kelly Madalinski	Project Coordinator	Port of Portland
Steve Misner	Project Manager	Apex Companies, LLC
Megan Masterson	Database Analyst	Apex Companies, LLC
Kelsi Evans	Quality Assurance/Quality Control Manager, Data Validator	Apex Companies, LLC
TBD	Field Lead	Apex Companies, LLC
Darrell Auvil	Laboratory Project Manager	Apex Laboratories

The Apex Companies Quality Assurance/Quality Control Manager is responsible for maintaining the official approved Sampling and Analysis Plan and Quality Assurance Project Plan.

Table of Contents

Tables

Attachments

Appendix C – Sampling and Analysis Plan / Quality Assurance Project Plan

1.0 Introduction

This sampling and analysis plan (SAP) and quality assurance project plan (QAPP) present a detailed account of field and laboratory procedures for sampling the riverbank and limited near-shore sediments at Terminal 4. This SAP includes the data quality objectives (DQOs) and quality assurance/quality control (QA/QC) procedures and specifies procedures and methods for office and field documentation, sample handling and custody, record-keeping, equipment handling, and laboratory analyses. This SAP was prepared in accordance with the United States Environmental Protection Agency (EPA) guidance, QA/G-5S (EPA, 2002b) and EPA QA/R-5 (EPA, 2001).

2.0 Sample Process Design

The riverbank characterization sampling design builds upon previous investigations and evaluations for source control at T4 to help develop a detailed conceptual site model (CSM) and further delineate sediment management areas (SMAs). Sediment samples will also be collected to support the PDI Work Plan (Anchor, 2019a). The sediment sampling is intended to refine the understanding of the nature and extent of contamination in the surface sediments (i.e. 0 to 30 centimeters [cm] below mudline [bml]) and determine risk and design remedial actions. The rationale for the proposed riverbank and sediment sampling is further described in Section 4.0 of the Riverbank Characterization Work Plan. Sampling locations are presented in Table 2 and are shown on Figure 4. Sample locations are also presented with contaminants of interest (COI) in Tables C-1 and C-3.

3.0 Riverbank Soil Sampling

3.1 Sample Locations

Proposed sample locations are shown on work plan Figure 4. Work plan Table 2 lists the sample location coordinates.

3.2 Sampling Methodology

Soil samples will be collected according to the standard operating procedure (Attachment C-1) and as described here. Surface debris (vegetation, rocks greater than one-half inch, woody material) will be moved aside. Riverbank soil will be collected by using a shovel or hand auger to a dig to a depth of 30 cm below ground surface (bgs). The soil sample will be collected from the fresh exposed soil from 0 to 30 cm bgs using a decontaminated stainless steel spoon. Any digging/sampling tools will be decontaminated between each location following the decontamination procedures outlined in Section 10.0.

Due to the potential presence of hard substrates or buried riprap beneath the riverbank sample locations, a minimum soil recovery thickness of 10 cm will be considered acceptable. If the recovery is less than 10 cm, the sample location will be moved following the protocols outlined in Section 4.2 of the Riverbank Characterization Work Plan. For probabilistic sample locations, if soil recovery is not achieved within the entire sampling unit, that sample will not be collected. The soil will be placed directly into a stainless steel bowl. The minimum volume collected will be 1.5 liters.

Samples collected for volatile organic compound analysis will not be collected from the homogenized sample. Rather, a discrete sample will be collected from the sidewall of the hand excavation at a depth of six inches below the ground surface. The sample will be collected using EPA Method 5035.

The field geologist or engineer will describe each soil sample, noting any indications of contamination based on sheen testing, olfactory response, and photoionization detector (PID) reading, and will describe the lithologic characteristics using the Unified Soil Classification System (USCS) in general accordance with ASTM 2487/2488. Other features such as sorting, sedimentary features, mineralogy, and contacts with other soil types will be noted, if relevant.

3.3 Sample Processing Procedures

Once the targeted sample interval has been collected, the soil sample will be thoroughly homogenized in the stainless steel bowl prior to placing in jars (except for samples collected for volatile organic compound analysis). Sample homogenizing is accomplished by manually mixing the entire soil sample in the stainless steel bowl with the sampling tool until a uniform mixture is achieved. After the sample containers are filled, any remaining soil will be returned to the sample point and the surface restored consistent with its original condition.

4.0 Surface Grab Sediment Sampling

During PDI sediment sampling in 2019, the sample vessel was unable to access the target locations of four surface sediment sampling points at former Pier 5 due to the presence of dense underwater pilings (Anchor QEA, 2019b). Three of the locations were moved into deeper water at Slip 3 and one location (SG07) was abandoned following EPA approval. Sediment samples will be collected at these four PDI locations at former Pier 5 using alternate methods at the target locations from the PDI Work Plan (Anchor QEA, 2019a).

This sampling will be conducted concurrent with the riverbank characterization sampling. The sections below detail the sampling locations, methods, and processing procedures.

4.1 Sample Locations

Consistent with the PDI Work Plan (Anchor QEA 2019a), Apex will collect four surface sediment grab samples from the locations presented on work plan Figure 4. Work plan Table 2 lists the sample location coordinates.

4.2 Sampling Methodology and Processing

Samples will be collected either from a portable watercraft able to navigate between pilings or using waders depending on water depth at the target sample locations. Each sample will consist of a 3-point composite. The three discrete samples will be equally spaced in a triangular pattern, with separation distances of approximately 1.5 to 3 meters (5 to 10 feet). The exact spacings and locations may need to be adjusted in the field due to the numerous piling obstructions but will not exceed a separation distance of 7.6 meters (25 feet) between discrete samples.

The samples will be collected from a depth of 0 to 30 cm below mudline (bml) using a side filling chambered-type discrete-point sampler (e.g. Russian Peat Borer). The Russian Peat Borer is appropriate for use in soft sediments, clay, peat, or other fine-grained materials. It consists of a one-meter long steel chamber and steel rods that can be linked with other rods to extend the total length. The bore chamber has a rotating steel blade and a sharp end. The borer is thrusted into the sediment and the sediment is locked into the chamber by rotating the blade. The borer is removed, laid on its side, and opened by rotating the chamber in the opposite direction, exposing the undisturbed sediment sample. The mudline is easily identifiable in the chamber and the top 30 cm will be removed from the borer and placed in a stainless steel bowl.

Consistent with the riverbank sampling methods described in Section 3.2, a minimum sediment recovery thickness of 10 cm will be considered acceptable. Equal portions of sediment will be collected at each discrete location and placed in stainless steel bowls. The minimum volume collected at each discrete location is 1 liter.

The field geologist or engineer will describe the sediment sample using the USCS in general accordance with ASTM 2487/2488. Pertinent technical comments and field observations (to include the presence of aquatic organism, anthropogenic debris, odor, or sheen) will be recorded, if observed.

Samples will be processed on-shore. Sample processing will include combining the three discrete samples in a decontaminated stainless steel bowl and homogenizing the sediment with a stainless steel spoon. The sample will be then transferred to laboratory approved containers and submitted to the analytical laboratory following appropriate handing and chain-of-custody requirements.

5.0 Sample Location Control

Horizontal sample location control will be achieved using a high-accuracy, handheld global positioning system device (GPS; Trimble© Gwo7X™) with sub meter accuracy. Sample locations will be pre-determined prior to the commencement of field activities and the target coordinates will be uploaded to the GPS. During sample collection, the field personnel will navigate to the target location to collect the sample. The actual sample collection location will be recorded in the GPS. To verify GPS accuracy, field staff will record a location at the nearest active City of Portland Bureau of Transportation benchmark (BM #2132), located approximately 500 feet southeast of the Site accessway along N Lombard Street. The recorded coordinates will be compared to the known benchmark location to assess accuracy.

Vertical positioning of riverbank characterization samples will be determined by comparing the recorded GPS coordinates with a high-resolution topographic map. The high-resolution topographic map will be prepared as part of the topographic survey discussed in Section 4.2 of the Riverbank Characterization Work Plan.

Vertical positioning of sediment sample locations will be determined by subtracting the depth to mudline from the river elevation at the time of sampling. Depth to mudline will be recorded using a pole fitted with an approximately 2 feet diameter perforated disc at one end. The disc is lowered down with the pole until mudline is reached. The pole is marked every tenth of a foot, and the depth to mudline is recorded from this measurement. River elevation will be determined at the time of each sampling using data from the United States Geologic Survey Willamette River gauging station (located at the Morrison Bridge in downtown Portland).

6.0 Documentation

Project files including this Sampling and Analysis Plan, Standard Operating Procedures (SOPs), and other documents used for this project will be kept up-to-date and filed electronically in a central project folder. The most recent documents will only be present in the main project folder and older versions will be kept at a separate archival location. All project personnel will have access to the main project folder and any updates to these documents will be communicated electronically with all project staff by the Project Manager.

Records pertaining to the project will include field records, GPS system data, chain-of-custody forms, and laboratory documentation. All project records will be stored and maintained in a secure manner by the Port for a minimum of ten years. The Project Manager is responsible for filing the necessary documents and ensuring their completeness. Finalized electronic records will be maintained by Apex and will be provided to the Port and the EPA upon request.

6.1 Field Documentation

Field activities and samples must be properly documented during the sampling process. Documentation of field activities provides an accurate and comprehensive record of the work performed sufficient for a technical peer to reconstruct the day's activities and provide certification that all necessary requirements were met. General requirements include:

- Use of project-specific field forms (provided in Attachment C-2).
    - The specific information requested depends on the nature of the work being performed and on the form being used. Information fields that are not applicable should be noted "N/A" or with other appropriate notations.
- Use of bound, waterproof field books as the primary source for information collection and recording. Field books should be dedicated to the project and appropriately labeled.
    - Appropriate header information documented on each page, including project title, project number, date, weather conditions, changes in weather conditions, other persons (if any) in the field party, and author.
- Field documentation entries using indelible ink.
- Legible data entries. A single line should be drawn through incorrect entries and the corrected entry should be written next to the original strikeout. Strikeouts are to be initialed and dated by the originator.
- Applicable units of measurement with entry values.
- Field records maintained in project files unless otherwise specified by a client or stipulated by a contract.
- Representative photographs of project activities. These photographs should be representative of the work being performed, and specific to the project. There must be sufficient photographs to create a photographic log of events if necessary, for reporting activities.

Concurrent with field sampling activities, Apex personnel will conduct a riverbank reconnaissance. The reconnaissance includes preparing detailed notes that include the following: surface conditions (i.e. areas of vegetation, armor, soil, retention features, or combination of); areas of observed erosion to include location, description, and approximate area measurements; and photographs for each sample cell.

6.1.1 Documentation Entries

A chronology of field events will be recorded. General entry requirements include:

- Visitors to the site;
- Summary of pertinent project communications;
- A description of the day's field activities, in chronological sequence using military time notation (e.g. 9:00 am: 0900, and 5:00 pm: 1700);
- If applicable, calibration of measuring and test equipment and identification of the calibration standard(s) and use of a Calibration Log, if available, with cross-reference entered into the field book;
- Field equipment identification, including type, manufacturer, model number, or other specific information;
- General weather conditions, including temperature, wind speed, and direction readings, including time of measurement and units;
- Safety and/or monitoring equipment readings, including time of measurements and units;
- If applicable, reference in the field notebook to specific forms used for collection of data;
- Substantive changes in the scope of work or modifications required based on field conditions will be documented on the Field Change Request Form and must be approved by the Port and EPA (Attachment C-2). Any communications with the Port or regulatory agencies to discuss such modifications will be documented; and
- Other unusual events.

6.1.2 Specific Requirements

Sample Collection. Sample collection data will be documented in a bound field book and/or on a sample collection form. Where both are being used, information contained in one is cross-referenced to the other. Entries include:

- Sample identification number, location taken, depth interval, sample media, sample preservative, collection time, and date;
- Sample collection method and protocol;
- Physical description of the sample (standard classification system for soil – ASTM D2488);
- If a composite sample, the sample's make-up, including number and locations (i.e. coordinates) of individual contributing grab samples;
- Quality-control-related samples collected (e.g. duplicates, blinds, trip blanks, field blanks);

- Container description and sample volume;
- Pertinent technical comments; and
- Identification of personnel collecting the sample.

Sample Labeling. Sample labels must be prepared and attached to sample containers. Labels will either be provided by the laboratory performing the analyses or will be generated internally and will be water-proof and self-adhering. The information to be provided includes:

- Sample identification number;
- Sample date and collection time;
- Physical description of the sample (e.g. soil, sediment, water);
- Analytical parameters;
- Preservatives, if present;
- Sample location; and
- Client.

Riverbank Soil and Sediment Collection Logs. The field logbook will include clear information concerning sample collection activities. Sample logging will be completed for each surface sediment sample. Sample logs will be recorded in bound field books. In addition to standard entries of personnel, date, and time, the log sheet will also include the following information:

- Names(s) of personnel logging the samples;
- Administrative and technical information included in the header;
- Types of equipment used;
- Descriptions of subsurface materials encountered, and the number and type of samples collected, if any;
- Subsurface exploration depth and units of measure;
- Length of recovery;
- Sample type and sample number for geotechnical or analytical samples collected (these data are also to be entered on the sample collection log, if used, and the sample label);
- Narrative description of the soil (using standard classification system) and other pertinent information; and
- Description of consistency of cohesive soils.

6.2 Analytical Documentation

All records pertaining to analytical data will be kept by the laboratory for a minimum of seven years. Analytical results will be provided as a PDF and electronic data deliverable (EDD) in a Microsoft Excel database format. Laboratory results for sample analysis will be stored electronically by Apex and the Port.

6.3 Data Reduction

Reports generated in the field and laboratory will be included with project reports. Data generated by the analytical laboratory will be provided electronically. The Project Manager will arrange for validation of the analytical data package by reviewing for any discrepancies between this SAP, the chain-of-custody, and analyses performed. If any discrepancies are found, the analytical laboratory will be contacted for additional information.

For reporting purposes, EDDs provided in a database format will be used to generate analytical data tables. All reportable data in tables will be checked against original laboratory reports. Data provided on field notes to be presented in data tables will be entered manually and 100% of manually entered data will undergo a secondary check for accuracy.

6.4 Reporting

Results will be presented in riverbank characterization report and the data will be evaluated to determine if cleanup actions are required at the Facility. The riverbank characterization report will include the following:

- Summary of field activities including field notes and forms;
- Sampling locations including GPS coordinates in both tabular and mapped format;
- Sampling results discussion with table format;
- Analytical data quality and validation review; and
- Screening of chemical analytical data against relevant regulatory criteria (i.e. Portland Harbor CULs, RALs, and PTW thresholds)

Reports will be submitted in a format approved by EPA, such as in pdf format with all metadata inserted, 508 tagging done to the extent practicable, in one file per deliverable (vs many), and include bookmarks to the extent practicable to enhance readability.

7.0 Analytical Testing Program

This section summarizes the analytical testing program for riverbank soil and sediment to be collected as part of the Riverbank Characterization Work Plan. Analytical testing will be completed in accordance with EPA-approved methods and this SAP/QAPP. Each analytical testing method has been reviewed to comply with DQOs, as defined in Section 9.0. As such, contract laboratories are expected to meet the following requirements:

- Prepare and analyze samples in accordance with analytical methods defined in this SAP/QAPP;
- Reporting requirements for deliverables including electronic data;
- Turnaround times;
- Implement QA/QC procedures as defined in the SAP/QAPP and in compliance with laboratory accreditation;
- Communicate any QA/QC errors that may affect data quality;
- Allow audits, if necessary.

7.1 Riverbank Soil

Table C-1 identifies the proposed chemical analyses for each sample. Analytes, methods, analytical laboratory, method detection limits, minimum reporting limits, and target detection limit goals are listed in Table C-2. Method detection limits included in Table C-2 were calculated by each laboratory using instrument-specific MDL study data and statistical analysis.

Riverbank soil will be analyzed for the COIs identified as a concern in that area. Overall, COIs include the following:

- Total petroleum hydrocarbons (TPH) as diesel and oil range organics by Northwest Method NWTPH-Dx;
- PAHs by EPA Method 8270E (low-level method);
- PCB Aroclors by EPA Method 1668A;
- Dioxins/furans by EPA Method 1613B;
- Organochlorine pesticides by EPA Method 8081A; and
- Metals (arsenic, cadmium, copper, lead, mercury, and zinc) by EPA Method 6020A.

Twenty percent (20%) of riverbank soil will be analyzed for the full suite of analytes. The full suite includes the COIs above in addition to the following:

- Chlorobenzene by EPA Method 8260C;
- Tributyltin ion by EPA Method 8270D-SIM; and
- Bis(2-ethylhexyl)phthalate by EPA Method 8270E.

Analytical methods will be performed by Apex Laboratories of Tigard, Oregon (OR01039), Bureau Veritas Laboratories (formerly Maxxam Labs) of Ontario, Canada (CN00023), and Analytical Resources Inc. (ARI) of Tukwila, Washington (WA00037). Turnaround time for data packages is expected to be 30 calendar days from the receipt of the last riverbank soil sample; however, turnaround times may be extended if complex matrices are encountered and require additional cleanup or dilution. Analytical data will be reported as Level 4 data packages but will be evaluated using Level 2B criteria unless further evaluation is necessary (EPA, 2009). Eurofins TestAmerica (TestAmerica) of North Canton, Ohio and ALS Global (ALS) of Burlington, Canada will be the backup laboratories to be used in the case the contract laboratories are unable to provide analytical services. TestAmerica will analyze for the full suite of analytes, with the exception of dioxins/furans and organochloride pesticides, which will be analyzed by ALS. Method detection achieved by the backup laboratories may be greater than the contract laboratories, but the backup laboratory will achieve reporting limit goals consistent with the performance of the contract laboratories, with the exception of dioxin/furan analysis. Method detection limits for several dioxins/furans compounds slightly exceed Portland Harbor CULs, but are below all other applicable screening levels.

7.1.1 Riverbank Soil Contingent Analytical Methods

Some analytical methods are contingent on initial results. EPA Method 8081B performed by Apex Laboratories is not able to achieve an MDL for dieldrin below the Portland Harbor CUL. Due to the number of samples to be collected and the costs associated with analyzing dieldrin with a high-resolution method (EPA 1699) needed to achieve the Portland Harbor CUL of 0.07 µg/kg, samples will be analyzed using EPA 8081B method as a screening method. If other chlorinated pesticides are detected in riverbank soil samples, and dieldrin is not detected above EPA 8081B reporting limits, then samples may be resubmitted for analysis by EPA 1699 with lower reporting limits for dieldrin. Holding time for pesticides in soil that has been stored at -18 degrees Celsius (°C) is one year from sample collection.

Additionally, PCBs will be analyzed by EPA 8082A for PCB Aroclors. The PCB method will achieve the total PCB Portland Harbor CUL but may reduce the level of data quality by over- or under- estimating PCB concentrations since the PCB Aroclor method relies on pattern recognition with second-column verification. The PCB Aroclor patterns may vary greatly depending on the amount of weathering of individual congeners and interferences may overestimate total PCB concentration. If PCB Aroclor patterns are detected in samples, then additional analysis by EPA 1668C for PCB congeners is recommended. The PCB congeners method is easier to detect and correct for results biased by interfering compounds, and quantitation of individual congeners is more accurate than estimating Aroclors. There are no demonstrated maximum holding times for PCBs due to their stability; however, it is recommended that samples are stored at -18°C for up to one year from collection.

7.2 Sediment

Table C-3 identifies the proposed chemical analyses for each sample. Sediment samples will be analyzed according to the PDI Work Plan (Anchor QEA, 2019a) and PDI Work Plan Addendum No. 1 (Anchor QEA 2019b). Material from every surface sample location will be archived in case delineation of additional COIs (e.g. dioxins/furans) or reanalysis of any COIs is needed based on the initial results. Reporting limit goals will be the same as those developed in the PDI Work Plan (Anchor QEA 2019a). Surface sediment will be analyzed by the following analytical methods:

- PAHs by EPA Method 8270E (low-level method);
- PCB congeners by EPA Method 1668A;
- Grain size by ASTM D422 modified;
- Total solids by Standard Method (SM) 2540G;
- Total organic carbon by EPA Method 9060A; and
- Dioxins/furans by EPA Method 1613B.

Analytical methods will be performed by Apex Laboratories of Tigard, Oregon (OR01039) and Bureau Veritas Laboratories (formerly Maxxam Labs) of Ontario, Canada (CN00023). Turnaround time for data packages is expected to be 30 calendar days from the receipt of the last sediment sample; however, turnaround times may be extended if complex matrices are encountered and require additional cleanup or dilution. Analytical data will be reported as Level 4 data packages but will be evaluated using Level 2B criteria unless further evaluation is necessary (EPA, 2009). TestAmerica of North Canton, Ohio and ALS of Burlington, Canada will be the backup laboratories to be used in the case the contract laboratories are unable to provide analytical services. Method detection achieved by the backup laboratories may be greater than the contract laboratories, but the backup laboratory will achieve reporting limit goals consistent with the performance of the contract laboratories, with the exception of dioxin/furan analysis. Method detection limits for several dioxins/furans compounds slightly exceed Portland Harbor CULs, but are below all other applicable screening levels.

8.0 Sample Containers and Handling

8.1 Container Requirements

Requirements for sample containers are provided in Table C-4. Samples will generally be collected in glass containers with Teflon®-lined lids to minimize adsorption and potential loss of analyte concentration. Containers will be supplied by the analytical laboratory and will be certified to not contain any trace contaminants of interest. For samples that require preservative, the laboratory will certify that all sample containers were prepared according to standard EPA protocol.

8.2 Labeling Requirements

A sample label will be affixed to every sample container before sample collection. Sample labels must be water-proof and self-adhere to sample containers. Labels will be provided by the laboratory and require the following information, as discussed in Section 6.1:

- Sample identification number;
- Sample date and collection time;
- Physical description of the sample (e.g. water, solid, gas);
- Analytical parameters;
- Preservatives, if present;
- Sample location; and
- Client.

8.3 Packaging and Shipping Requirements

Each individual sample container will be wrapped with bubble wrap or other suitable packing material and immediately packed in a cooler with wet ice. One copy of the chain-of-custody form will be placed in a sealed plastic bag taped to the inside of the cooler lid. The samples will be either be delivered to the analytical laboratory by Apex or a courier service, or the laboratory will pick up the samples within 48 hours of collection. Chain-of-custody seals will not be necessary for coolers since samples will be transported directly to the laboratory.

9.0 Data Quality Objectives

The general data quality objectives for this project are to develop and implement procedures for obtaining and evaluating data of a specified quality that can be used to evaluate sediment and riverbank soil conditions. Soil data will be collected to evaluate whether bank erosion is a significant pathway for recontamination of the Willamette River PHSS sediments. Sediment data will be used to evaluate risk and design remedial actions. This will be achieved by conducting chemical and physical characterization of the T4 riverbank and nearshore sediment data. The objectives of soil and sediment characterization are: (1) Define the extent of contamination in riverbank soils relative to applicable screening levels; (2) refine the conceptual site model (CSM); (3) further delineate sediment management areas (SMAs); and (4) identify physical characteristics of the riverbank to support an erodibility evaluation. Sediment evaluation data quality objectives are consistent with those presented in the PDI Work Plan (Anchor, 2018).

9.1 Decision

The decision uses environmental data to determine if additional investigation, characterization, or remediation is needed. Data collected for riverbank soil and sediment will be used to evaluate if riverbank soil contamination or sediment contamination exceeds applicable regulatory levels presented in the ROD (CULs, RALs, and PTW thresholds) or screening level values from the Joint Source Control Strategy (JSCS) when ROD levels are not available. Contaminant concentrations present above these levels may trigger further evaluation, including evaluation of potential cleanup actions, if warranted.

9.2 Inputs

To support the decision, an evaluation of existing site information will be performed to aid in the identification of representative sections of the riverbank and their characteristics pertaining to erodibility and transport of contamination. Existing site information will include (if available) a review of previous site reconnaissance, site plans, topographic maps, aerial photographs, lidar maps, geologic maps, soil survey information in the vicinity of the Site, previous investigation data, boring logs, well logs, geotechnical reports, and bathymetry maps for the Willamette River.

Historical chemical concentration data was reviewed and incorporated into the preparation of this work plan. The age and representativeness of historical chemical data and the availability of more recent data will be considered when evaluating the use of historical data. Historical data will be replaced by current sample data in instances where current data was collected within 100 feet of historical data.

In addition to historical records, additional site surveying will be necessary to assess riverbank stability. A high-resolution topographic survey of the T4 riverbank will be performed to support riverbank stability evaluations and create profile sections. Evaluation of erosion potential will also include visual reconnaissance of the riverbank, evaluating results from the topographic survey, assessing potential for erosion of the bank from river action, and assessing potential for erosion from surface soil and overland flow. The riverbank erodibility evaluation will be based on a weight-of-evidence approach, as described in EPA Guidance (EPA 2019) which standardizes the requirements for both ROD riverbanks and JSCS riverbanks. Data and information collected during the initial assessments will be evaluated using the quantitative Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model.

To characterize chemical concentration, riverbank soil sampling will be conducted using a combined probabilistic-based and judgmental sampling design in the area from the top of bank (TOB) to -2 feet Columbia River Datum (CRD) from 0 to 30 cm below soil surface as described in Section 3.0. Probabilistic and judgement sampling methods were selected as the most appropriate approaches to delineate areas where contaminant concentrations exceed CULs, RALs, and PTW thresholds (EPA, 2019). Laboratory preparation and analytical methods were chosen to meet CULs, RALs, and PTW thresholds using accredited methods and laboratories for soil and sediment analysis through the National Environmental Laboratory Accreditation Program (NELAP) and the Oregon Environmental Laboratory Accreditation Program (ORELAP).

The results from the erodibility evaluation will be compared with the chemical characterization results, to determine if riverbank erosion is a pathway of concern for recontamination to the Willamette River. Based on the findings, a supplemental evaluation and/or a remedial design evaluation may be required and includes a more in-depth evaluation of erosion factors, such as: riverbank erosion caused by overland runoff; erosion resulting from anthropogenic causes such as foot paths or vehicles; erosion forces during flood conditions above bank-full river levels; erosional forces caused by wind waves; erosional forces caused by boat wakes; assessment of the condition of the riverbank surface, including evidence of erosion, deposition, or slope movement; examination of the bank for areas of groundwater seeps and piping that might affect the bank stability; a detailed topographic survey of the entire riverbank; and slope stability analysis performed under the supervision of an Oregon Professional Engineer with expertise in geotechnical engineering or a Certified Engineering Geologist.

9.3 Boundaries of Study

The sampling area is shown on Figure 4 and includes the riverbank area from the top of bank (TOB) to -2 feet CRD. Surface soil (0 to 30 cm below soil surface) will be sampled as part of the chemical characterization since this layer is subject to erodibility. The boundaries of this study were determined based on the ASAOC (Docket No. Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] 10-2004-0009) boundary, property boundary, riverbank reconnaissance, and as defined in the Riverbank Guidance document (EPA, 2019).

9.4 Rule

If COIs in riverbank soil are above CULs, RALs, or PTW thresholds, then additional remedial actions may be necessary to limit the erodibility or reduce the exposure concentrations of contaminated riverbank soil.

9.5 Tolerable Limits

Errors in sampling and measurement contribute to the total study error and will reflect directly in the decision error. If riverbank soil exceeds regulatory levels (CULs, RALs, or PTW thresholds), then confirmation sampling/analysis may be necessary to support appropriate site management decisions.

9.6 Optimizing the Design

The schedule and sampling design may incur delays or obstruction due to uncontrollable circumstances. In these cases, alternative plans will be discussed with the Port and EPA.

10.0 Decontamination Procedures

Consistent decontamination procedures will be used for all sampling and laboratory procedures. The objectives of decontamination are to prevent the introduction of contamination into samples from sampling equipment or other samples, to prevent contamination from leaving the site via sampling equipment or personnel, to prevent exposure of field personnel to contaminated materials, and to prevent cross-contamination within the laboratory.

10.1 Personnel Decontamination

Personnel decontamination procedures depend on the level of protection specified for a given activity. Regardless of the level of protection required, field personnel should thoroughly wash their hands and faces before taking any work breaks and at the end of the day.

10.2 Sampling Equipment

Decontamination procedures are designed to remove trace-level contaminants from sampling equipment to prevent the cross contamination between sample collection locations. To prevent cross contamination between sample locations, clean dedicated sampling equipment will be used for each sampling event and discarded or cleaned after use. Cleaning of non-disposable items will consist of washing in a detergent (e.g., Alconox®) solution, rinsing with tap water, followed with a deionized water rinse. This process will be repeated if visual signs of contamination are still present.

10.3 Laboratory Decontamination

Laboratory decontamination will involve strict adherence to laboratory SOPs and best practices. All work areas and equipment must be appropriately cleaned between samples to prevent cross-contamination. The laboratory will certify that laboratory-based contamination is not present by analyzing calibration blanks, instrument blanks, and/or method blanks at method-specified intervals. If contamination is present, then additional instrument cleaning or re-extraction may be necessary.

11.0 Investigation Derived Waste Handling

While sampling, excess sediment that will not be submitted to the laboratory may be placed back in its original collection area or emptied overboard the vessel. If a sheen or nonaqueous phase liquid is present, then the sediment will be containerized and brought to shore, where it will be disposed of as investigation-derived waste (IDW). Excess volume of riverbank soil that has been processed as a composite and decontamination water will also be considered IDW.

IDW will be containerized on-site in Department of Transportation (DOT)-approved drums for disposal. Each drum will be labeled with the project name, general contents, and date. The selected disposal option will be determined based on analytical results of the samples. Drums will be transported off-site and disposed of within 90-days from sample collection. Disposable items, such as gloves, protective overalls (e.g., Tyvek®), paper towels, etc., will be placed in plastic bags after use and deposited in trash receptacles for disposal.

12.0 Quality Assurance Plan

12.1 Quality Assurance Objectives for Measured Data

The elements included in this section are consistent with those specified in EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5 (EPA, 2001). The general quality assurance (QA) objectives for this project are to develop and implement procedures for obtaining and evaluating data of a specified quality that can be used to evaluate sediment and riverbank soil conditions. To collect such information, analytical data must have an appropriate degree of accuracy and reproducibility, samples collected must be representative of actual field conditions, and samples must be collected and analyzed using unbroken chain-of-custody procedures.

The data quality objectives (DQOs) for this project are presented in Section 9.0 and were established based on the EPA Guidance for the Data Quality Objectives Process, EPA QA/G-4 (EPA, 2006). They are the basis for the design of the data collection plan and, as such, the DQOs specify the type, quality, and quantity of data to be collected and how the data are to be used to make the appropriate decisions for the project.

Method detection limits (MDL), minimum reporting limits (RL), and analytical results will be compared to action levels for each COI in the media of concern as part of the DQOs. The MDLs and RLs listed in Table C-2 are the expected limits based on instrument capabilities. In some cases, sample matrix or high target analyte concentrations may increase these limits. If sample conditions are such that MDLs exceed the screening levels, an acceptable alternative will be determined.

Specific QA objectives are as follows:

1. Establish sampling techniques that will produce analytical data representative of the media being measured.
2. Ensure that data collection and measurement procedures are standardized among all participants.
3. Monitor the performance of the various measurement systems being used in the program to maintain statistical control and provide rapid feedback, so that corrective measures, if needed, can be taken before data quality is compromised.
4. Periodically assess the performance of these measurement systems and their components.
5. Verify that reported data are sufficiently precise, accurate, representative, comparable, and complete, so that they are suitable for their intended use.

Precision, bias, accuracy, representatives, completeness, comparability, and sensitivity parameters are used as data quality indicators (DQI) and are defined below. Measurement parameters for DQIs are included in Table C-5.

12.1.1 Precision

Precision is a measure of the reproducibility of data under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average value. For duplicate measurements, precision can be expressed as the relative percent difference (RPD). Duplicate measurements can include the following field and laboratory QC samples: field duplicates; laboratory duplicates; matrix spike (MS) and matrix spike duplicate (MSD) batch pairs; and/or laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) batch pairs.

The RPD is calculated using the following equation:

$$RPD = \frac{X_s - X_d}{(X_s + X_d)/2} \times 100\%$$

(1)

where:

X_s = analytical result of the primary measurement

X_d = analytical result of the duplicate measurement

12.1.2 Bias

Bias is the persistent distortion of measurement data that can cause an error in either direction (high or low). Bias can be determined from field blanks, trip blanks, equipment blanks, LCS/LCSDs, MS/MSDs, and surrogates.

12.1.3 Accuracy

Accuracy is the measure of error between the measured concentration and the accepted reference value. Accuracy is inferred from the recovery data of laboratory spiked samples. Quality assurance samples used to measure accuracy include: LCS/LCSDs, MS/MSDs, and surrogates. Surrogates are implemented when organic constituents are of interest.

Accuracy is calculated using the following equation:

$$A = \frac{(X_{ss} - X_s)}{T} \times 100\%$$

(2)

where:

A	=	accuracy
X_{ss}	=	analytical result obtained from the spiked sample
X_s	=	analytical result obtained from the sample
T	=	true value of the added spike

12.1.4 Representativeness

Representativeness is a measure of how closely the data reflect the characteristic of a population, variation in parameters at a single location, a process condition, or an environmental condition. This data quality indicator is dependent in the design and proper implementation of the sampling program. Development of sampling plans include considerations such as site history, geography, demography, waste present, field screening parameters, data quality objectives, analytical parameters and methods and sampling approaches. Documentation of field activities will confirm that protocols are followed according to the sampling plan. In addition to documentation, QC samples are also used to show that field screening and laboratory results are representative of actual field conditions. These QC samples may include as appropriate: field blanks, trip blanks, equipment blanks, and field duplicates.

12.1.5 Completeness

Completeness is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is essentially that a sufficient amount of valid data be generated. Completeness will be judged by the Project Quality Assurance Manager and the Project Manager based on laboratory data quality and adherence to field sampling protocols. The completeness goal for this project is 95%.

Completeness (percent complete, or PC) of the data is determined by the following equation:

(3) $$PC = \frac{\text{Number of samples with valid data}}{\text{Number of planned samples}} \times 100\%$$

12.1.6 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. The objective is to assure that all data developed during the sampling are comparable. Comparability of the data will be assured by using EPA-defined procedures which specify sample collection, handling, and analytical methods.

12.1.7 Sensitivity

Sensitivity is the ability of an analytical method or instrument to discriminate between measurement responses representing different concentrations. This capability is established during the planning phase to meet project-specific objectives. It is important to be able to detect the target analytes at the levels of interest. Sensitivity requirements include the establishment of various limits, such as, method detection limits (MDLs), and project-specific reporting limits (RLs) and calibration requirements. The MDLs are normally based on an interference-free matrix (that is, reagent water or purified solid), which do not consider matrix effects and may not be achievable for environmental samples.

12.2 Quality Control

This section includes quality control checks that will be used to determine data quality. Control limits are presented in Table C-5 and the frequency of analysis of quality control samples is included in Table C-6.

12.2.1 Field Quality Control Samples

Equipment Blanks. An equipment blank is a sample prepared in the field by rinsing equipment with deionized blank water after decontamination. The laboratory then analyzes that rinsate water for target analytes to determine if cross-contamination may have been present in the field. An equipment blank will be collected for each sample collection method and will be analyzed by methods presented in Table C-2. If contaminants are present at concentrations greater than the reporting limit, then cross-contamination may have occurred. If target analytes are detected in samples above the reporting limit and less than ten times the equipment blank concentration, then those samples may reflect possible high bias due to contamination and will be 'J+' flagged within data tables provided by Apex. Analytical data may not be corrected based on the concentration found in the equipment blank.

Field Duplicates. A field duplicate is a separate sample collected along with the primary sample to document sampling and analytical precision and representativeness. Field duplicates will be collected at a minimum frequency of one per 20 samples collected. The RPD for results greater than five times the reporting limit must be less than 50%. For results that are less than five times the reporting limit, the absolute difference between the two results must be less than ±2 times the reporting limit. If either of these criteria are exceeded, then detected results will be 'J' flagged as estimated values

12.2.2 Laboratory Quality Control Checks

Holding Times. The holding time requirements specified in Table C-4 are method derived and must be met to ensure true representation of field conditions. The holding time begins once the sample is collected and is dependent on sample preservation and collection procedures. A secondary holding time may occur for samples that require extraction and includes the time from sample preparation to analysis. Depending on the method, the holding time concludes when the sample is analyzed or when the sample is prepared. If holding times are exceeded detected results will be 'J' flagged and not detected results will be 'UJ' flagged. If gross exceedances occur (greater than two times the original holding time) then results will be 'R' flagged as unusable. PCBs and dioxins/furans are stable and persistent in the environment and do not have a recommended holding time; therefore, holding time exceedance will be evaluated based on professional judgement and national guidance.

Instrument Calibration. Instrument calibration includes periodic calibrations at defined intervals and operational calibrations that are performed daily. Qualified personnel will calibrate laboratory instruments prior to sample analysis according to the procedures specified in each method and the Laboratory QA/QC manager is responsible for ensuring that instruments are calibrated in accordance with SOPs. Calibration shall be verified at method-specified intervals throughout the analysis sequence and standards must be vendor-certified. The frequency and acceptance criteria for calibration are specified for each analytical method. When multipoint calibration is specified, the concentrations of the calibration standards should bracket those expected in the samples. Samples should be diluted, if necessary, to bring analyte responses within the calibration range. Data that exceed the calibration range cannot be reported by the laboratory unless qualified as an estimated value. The initial calibration curve shall be verified as accurate with a standard purchased or prepared from an independent second source. The initial calibration verification involves the analysis of a standard containing all the target analytes, typically in the middle of the calibration range, each time the initial calibration is performed. Instrument calibration requirements per method are included in Table C-6.

Calibration Blanks. A calibration blank or instrument blank will be prepared and analyzed before samples are to be analyzed and at continued method-specified intervals. Detections in the calibration blank must be less than five times the concentration detected in samples. If this is exceeded, the source of the contamination should be identified and corrected, and samples should be reanalyzed.

Instrument Performance Checks. Analysis methods that require a mass spectrometer detector must check instrument performance with an ion abundance standard. The ion abundance standard or tune check solution should meet method and instrument manufacturer guidelines. If the instrument check does not meet these criteria, then analysis should be halted, and the source of the error should be identified and corrected.

Sample Dilution. Dilutions must be made if sample concentrations exceed the upper limit of quantitation. Samples will be diluted to approximately the mid-range of the calibration curve and final dilution results must be above the reporting limit.

Surrogates. Surrogates are organic compounds that are similar in chemical composition to the analytes of interest but are not likely to be found in the environment. They are spiked at a known concentration into environmental and batch QC samples prior to sample preparation and analysis. Surrogate recoveries for environmental samples are used to evaluate matrix interference, sample preparation efficiency, and analysis performance on a sample-specific basis. Surrogates will be controlled according to method and laboratory criteria. If the recovery of the surrogate is above the upper control limit, then detected may be 'J+' flagged as estimated values that may be biased high, and not detected values will not be qualified. If the surrogate recovery is below the lower control limit, then detected values may be 'J-' flagged as estimated values that may be biased low, and not detected values will be 'UJ' flagged as estimated not detected values at the reporting limit. If surrogates are outside of the control limit due to dilution, then results are considered estimated.

Method Blanks. A method blank (MB) is a quality control sample prepared by the laboratory from an analyte-free matrix similar to samples within the analytical batch and are analyzed along with environmental and other QC samples. Method blank samples are prepared and analyzed exactly as other field samples within the analytical batch, following the same initial and final volumes, complete sample preparation, cleanup steps, and analytical procedures. It is used to assess laboratory contamination or background interferences that might result in elevated concentration levels or false positive data. Results for the method blank must be below the reporting unless target analytes are not detected above the reporting limit within associated batch samples or the concentration found in the samples is ten times greater than the method blank concentration. If target analytes are present in the MB and the sample, sample results must be compared to the MB results prior to the calculation for dilutions, if a dilution was performed on the sample. Corrective action must be taken by the laboratory if target analytes are detected in batch samples above the reporting limit and less than ten times the MB concentration. Depending on holding time violations and other factors, samples will need to be re-prepared and re-analyzed to eliminate the contamination source. Any samples that reflect possible high bias due to contamination will be 'B' flagged by the laboratory and 'J+' flagged within data tables provided by Apex. Analytical data may not be corrected based on the concentration found in the MB.

Laboratory Duplicates. A laboratory duplicate is a secondary aliquot taken from a field sample by the laboratory which is prepared and analyzed by the laboratory by the same method specifications as other samples within the analytical batch. The RPD between the primary and duplicate analysis are calculated and demonstrates the precision of the laboratory. In soil and biphasic samples, it would also indicate homogeneity. RPD values should be less than the method or laboratory criteria. If the RPD control criteria is exceeded, detected results will be 'J' flagged as estimated values.

Laboratory Control Samples. The LCS will consist of analyte-free matrix, depending on the batch matrix, spiked with known amounts of target analytes that come from a source different than that used for calibration standards. The LCS is used to assess laboratory method performance by recovering analytes within a matrix and reflects accuracy within an analytical batch. If LCS results are outside the specified control limits, corrective action must be taken, including sample re-preparation and/or reanalysis, if appropriate. A laboratory control sample duplicate (LCSD) is analyzed to assess precision by comparing the primary and duplicate individual analyte results. The RPD between the initial and duplicate LCS is calculated and must be within control limits. Any LCS recovery outside of QC limits affects results within the entire batch and will require qualification and corrective action.

Depending on the recovery of the target analyte, detected results may be 'J+' or 'J-' flagged as estimated values with either a high or low bias, respectively. If a target analyte is detected above the upper control limit and the associated sample is not detected for this same analyte, then no qualification is necessary. If the target analyte is recovered below the lower control limit and the analyte is not detected in the associated sample, then the not detected value is estimated at the reporting limit and is 'UJ' flagged.

If the RPD between the LCS and LCSD exceeds the control limit, then detected results will be 'J' flagged and not detected results will not be qualified.

Matrix Spikes. A matrix spike (MS) is a field sample spiked with target analytes of a known concentration before sample preparation and is analyzed by method specifications like other samples within the analytical batch. The recovery of target analytes indicates possible sample matrix interferences and possible bias can be assumed if recoveries are outside of control limits. A duplicate matrix spike (MSD) is analyzed and individual analyte results are compared to the initial MS, which is expressed as an RPD. If the MS or MSD exceed quality control criteria, then only the sample used as the source will be qualified. If the recovery or RPD of target analyte is outside of the control limit, then the analyte detections in the source sample will be 'J' flagged. If the analyte is not detected in the sample and the analyte recovery is above the upper control limit, then data will not be qualified. If the analyte is not detected in the sample and the analyte recovery is below the lower control limit, then data will be 'UJ' flagged.

12.2.3 Quality Control Flags and Qualifiers

Data qualifier flags, if required, are defined below, and will be applied to the electronic sample results. If multiple flags are required for a result, the most severe flag will be applied to the electronic result. The hierarchy of flags from the most severe to the least severe will be as follows: R, J, UJ, U.

Flag	Definition
J	The reported value is an estimated concentration of analyte in the sample.
J+	Failure of quality control criteria suggest result is estimated and biased high.
J-	Failure of quality control criteria suggest result is estimated and biased low.
R	Quality control criteria was not met, and the resulting data is rejected.
U	This analyte was analyzed for but not detected at or above the specified detection limit.
UJ	The analyte was not detected in the sample, but the quantitation limit is estimated due to quality control failures.

12.3 Special Training or Certification

Apex staff that will be performing the field sampling are required to have completed the 40-hour OSHA HAZWOPER training course with a current annual 8-hour refresher. All staff will be trained on the collection and processing procedures for riverbank soil and sediment.

Laboratory QA department personnel will maintain records documenting the ability of each analyst to perform applicable method protocols. Documentation will include initial checks on the analyst's ability to produce accurate and precise data for preparation and instrumental analysis procedures. The laboratory will participate in annual

Performance Evaluation (PE) samples to comply with NELAP and ORELAP accreditation. The laboratory will also be subject to on-site assessments performed by ORELAP.

12.4 Sampling Protocols

12.4.1 Methods

Sampling methods are presented in Sections 3 and 4. These procedures are designed to ensure that:

- All samples collected are consistent with DQOs; and
- Samples are identified, handled, and transported in a manner that does not alter the representativeness of the data from the actual site conditions.

12.4.2 Sample Containers, Preservation, and Holding Times

The contracted analytical laboratory will provide the required sample containers for all samples, including QC. All containers will have been cleaned and certified free of the analytes of concern for this project. Sample containers may not be reused. The contracted laboratory will add analyte-free preservatives to sampling containers. The case narrative will include any container issues and what corrective action was taken, if any.

The containers, minimum sample quantities, required preservatives, and maximum holding times for project analytes are described in Table C-4

12.5 Sample and Document Custody Procedures

The various methods used to document field sample collection and laboratory operation are presented below and in Section 6.

12.5.1 Field Chain-of-Custody Procedures

Sample chain of custody refers to the process of tracking the possession of a sample from the time it is collected in the field through the laboratory analysis. A sample is considered to be under a person's custody if:

- It is in a person's physical possession;
- In view of the person after possession has been taken; or
- Secured by that person so that no one can tamper with the sample or secured by that person in an area which is restricted to authorized personnel.

A chain-of-custody form is used to record possession of a sample and to document analyses requested. Each time the sample bottles or samples are transferred between individuals, both the sender and receiver sign and date the chain-of-custody form. When a sample shipment is transported to the laboratory, a copy of the chain-of-custody form is included in the transport container (i.e., ice chest).

The chain-of-custody forms are used to record the following information:

- Sample identification number;
- Sample collector's signature;
- Date and time of collection;
- Description of sample;
- Analyses requested;
- Shipper's name and address;
- Receiver's name and address; and
- Signatures of persons involved in chain of custody.

12.5.2 Laboratory Sample Custody

Once the samples reach the laboratory, all information on the Chain of Custody (COC) form will be checked against sample labels for discrepancies. The condition, temperature, and appropriate preservation of samples will be checked and documented on the COC form. The sample integrity issues in the received samples and their resolution will be documented in laboratory records. All sample information will then be entered into a laboratory information management system, and unique analytical sample identifiers will be assigned.

Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Subcontracted analyses will be documented with the COC form. Samples will be stored by the laboratory at the temperatures specified in Table C-4. Temperatures of storage refrigerators will be checked twice daily and recorded by the analytical laboratory. Samples will be stored by the laboratory and disposed of in accordance with applicable local, state, and federal regulations. Disposal records will be maintained by the laboratory.

12.5.3 Analytical Documentation

All records pertaining to analytical data will be kept by the laboratory for a minimum of five years. Where applicable by analytical method, these records may include: calibration data, instrumentation performance checks, matrix checks, internal standard recovery data, surrogate recovery data, qualifier ion and spectra data, blank analysis data, retention times, second-column compound confirmation, method detection limit studies, reporting limit standard recoveries, laboratory analytical batch quality control samples, analytical run logs, analytical batches, bench sheets, sample storage logs, and proficiency testing information.

Analytical data will be reported as Level 4 data packages but will be evaluated using Level 2B criteria unless further evaluation is necessary (EPA, 2009). This includes a case narrative, sample matrix, collection date/time, receipt date/time, sample results corrected for dilution, dilution factors, detection limits, reporting limits, units, extraction/preparation date/time, analysis date/time, qualifiers with definitions, quality control sample results (surrogates, method blank, laboratory control samples, matric spikes, laboratory duplicates), quality control sample recovery limits, chain-of-custody documentation, and sample integrity observations upon receipt. Analytical results will be provided as a PDF and electronic data deliverable (EDD) in a Microsoft Excel database format. Laboratory results for sample analysis will be stored electronically by Apex and the Port.

12.5.4 Corrections to Documentation

All original data are recorded in field notes and on chain-of-custody forms using indelible ink. Documents will be retained even if they are illegible or contain inaccuracies that require correction.

If an error is made on a document, the individual making the entry will correct the document by crossing a line through the error, entering the correct information, and initialing and dating the correction. Any subsequent error discovered on a document is corrected, initialed, and dated by the person who made the entry.

12.6 Instrument/Equipment Testing, Inspection, and Maintenance

This section presents the procedures for testing, inspection, and maintenance for field and laboratory equipment. Laboratory SOPs that address specific procedures are provided in Attachment C-3.

12.6.1 Field Instrument/Equipment

Maintenance responsibilities for field equipment are assigned to the field team leader for specific sampling tasks. However, the field team using the equipment is responsible for checking the status of the equipment prior to use and reporting any problems encountered. Field equipment will be inspected daily before the start of work. Maintenance will be performed following manufacturers guidelines, or when equipment is not performing optimally (not calibrating correctly, apparent drift in readings, or giving readings that are not likely for the apparent field condition). Equipment will be tested before leaving for the field site. If any errors are indicated, the field equipment will not be used, and backup equipment will be rented from a reputable rental company until the faulty equipment can be serviced. Any equipment that cannot be serviced will be replaced. Equipment/Instruments that will be used in the field include a Photoionization Detector (PID; MiniRAE 3000) and a handheld global positioning system device (GPS; Trimble© Gwo7X™).

12.6.2 Laboratory Instrument/Equipment

Laboratory instrument maintenance is the responsibility of the participating laboratory. Generally, the quality assurance manager is responsible for adhering to instrument maintenance schedules. This responsible person will establish maintenance procedures and schedules for each instrument. Manufacturers' recommendations should provide the primary basis for establishing maintenance schedules. Manufacturers' service contracts may be used for implementing the scheduled maintenance. A summary of SOPs for Apex Laboratories, accreditations, and a table summarizing support equipment calibration and maintenance schedules are provided in Attachment C-3. SOPs for subcontract laboratories are discussed in the text below.

Subcontract laboratories include Bureau Veritas Laboratory and Analytical Resources, Inc. Bureau Veritas Laboratory will conduct the analysis for dioxin/furans, dieldrin, and PCB congeners, if applicable. Dioxins/furan analysis and prep method is based off of EPA 1613 with Soxhlet extraction, mixed bed silica, alumina and carbon clean up OR EZ123 prep system (CAM SOP-00407, CAM-SP-00405). Dieldrin analysis and prep method is based off of EPA 1699 with solvent extraction, florisil column clean up (CAM SOP-0014). PCB analysis and prep method is based off of EPA 1668C with Soxhlet extraction, acid silica and florisil column clean up (CAM SOP-00409).

Analytical Resources, Inc. will conduct the analysis for tributyltin ion. Solid tributyltin will use EPA 3550C for Microwave (GC) and EPA 3546 for Sonification (GCMS) (3304S revision 006 and 802S revision 006, respectively).

Detailed SOPs may be made available upon request from the analytical laboratory for internal review only.

12.7 Instrument/Equipment Calibration Procedures and Frequency

This section presents the calibration procedures and frequency for field and laboratory equipment.

12.7.1 Field Instrument/Equipment

Field equipment will be calibrated before the start of work. Calibration will be in accordance with procedures and schedules outlined in the manufacturer's operations manual. Calibrated equipment will be uniquely identified by using either the manufacturer's serial number or other means. Equipment that fails calibration or becomes inoperable during use will be removed from service and either segregated to prevent inadvertent use or tagged to indicate it is out of calibration. Such equipment will be repaired and satisfactorily recalibrated. Equipment that cannot be repaired will be replaced.

12.7.2 Laboratory Instrument/Equipment

Laboratory calibration procedure requirements are discussed in Section 12.2 and 12.6.

12.8 Non-direct Measurements

Existing data from databases, previous sampling efforts, historical documents, and technical reports were reviewed for usability. Existing data suitable for use in the evaluation of results and production of the report have been identified in Section 2.6 of the Riverbank Characterization Work Plan. Criteria that will be used to evaluate the riverbank soil results will include the following:

- Existing data from the PDI Summary Report;
- Historical riverbank data collected under oversight of USEPA or DEQ and in an area adjacent to the T4 Action Area;
- Existing upland data (soil, groundwater) collected under oversight of USEPA or DEQ and in an area adjacent to the T4 Action Area;
- Bathymetry data and other survey data collected for the Portland Harbor Remedial Investigation/Feasibility Study;
- Portland Harbor RALs and cleanup goals included in the ROD or subsequent addenda.

12.9 Data Reduction, Validation, and Reporting

Reports generated in the field and laboratory will be included with project reports.

The Project Manager will assure validation of the analytical data. The laboratory generating analytical data for this project will be required to submit results that are supported by sufficient backup and QA/QC data to enable the reviewer to determine the quality of the data. Validity of the laboratory data will be determined based on the quality control objectives outlined in Section 12.2. Data validity will also be determined based upon the sampling procedures and documentation outlined in Sections 3 and 4. Upon completion of the review, the Project Manager will be responsible for assuring development of a QA/QC report on the analytical data. The Data Management Plan in Attachment C-4 outlines how the data will be handled form planning, field, and post-field work. The process for archiving and retrieving the data and the responsible individuals are included in the Data Management Plan. Data reduction is described in Section 6.3.

12.10 Performance Evaluations

To assess sample and data collection procedures, performance evaluations will be conducted and will consist of technical systems audits and field audits.

12.10.1 Field Audits

A minimum of one field audit will be performed by Apex personnel independent of the project. The field audit will be performed in accordance with the checklist included in Attachment C-2. The field audit will involve a review and evaluation of implementation of approved work procedures, sampling procedures, sampling documentation, labeling, packaging, storage, and shipping of samples; completion of field records; QC compliance; and field change documentation. Field records will also be reviewed to verify that field-related activities are performed and documented in accordance with the SAP/QAPP. The audit will be conducted in the period when approximately 10 to 20 percent of the field work is completed. The Project Manager will be responsible for identifying the appropriate schedule for audits and selecting the proper personnel to conduct the audits.

12.10.2 Laboratory Audits

The project consultant may perform project-specific audits, if necessary. Laboratory audits will consist of a review of laboratory documentation and recordkeeping, adherence to laboratory QA/QC and SOPs, facilities and instrumentation, and personnel. Deficiencies will be discussed with the project laboratory as part of the audit process; corrective action reports addressing any deficiencies noted during the audit will be submitted by the project laboratory no more than 15 days after the audit.

Annual audits of the laboratory shall be conducted by the laboratory's QA officer. The audits will verify, at a minimum, that written SOPs are being followed; standards are traceable to certified sources; documentation is complete; data review is being done effectively and is properly documented; and data reporting, including electronic and manual data transfer, is accurate and complete. All audit findings are documented in QA reports to laboratory management. Necessary corrective actions shall be taken within a reasonable timeframe. The QA officer will also verify that such actions are effective and complete and shall document their implementation in an audit closeout report to management.

Apex Laboratories maintains a quality management system in accordance with the 2009 TNI Standard (EL-V1-2009) and ISO/IEC 17025:2005. In compliance with these guidelines, internal audits and management review are performed on a prescribed basis. Ongoing verification of these compliance activities is conducted by ORELAP a NELAP recognized accreditation body (AB).

12.11 Field and Laboratory Corrective Action

Conditions adverse to data quality must be promptly investigated, evaluated, and corrected. Adverse conditions may include instrument malfunctions, deficiencies in quality control criteria, deviations from SOPs, and errors in data reduction, validation, or documentation.

12.11.1 Field Corrective Action

Any project team member may initiate a field corrective action process. The corrective action process consists of identifying a problem, acting to eliminate the problem, monitoring the effectiveness of the corrective action, verifying that the problem has been eliminated, and documenting the corrective action.

Field corrective actions can include such activities as correcting COC forms, solving problems associated with sample collection, re-packing samples to ensure sample integrity, correcting an entry in field notes, or providing a team member with additional training in sampling procedures. More extensive corrective actions might involve re-sampling or evaluating and revising sampling procedures. The field team leader will summarize the problem, establish possible causes, and designate the person responsible for a corrective action. The field team leader will then verify that the initial action has been taken and that it appears to be effective. Finally, the field team leader will follow up at a later time to verify that the problem has been resolved.

If a corrective action could potentially affect the quality of the analytical process, the field team leader must notify the Project Manager immediately. Substantive field changes will be documented on the Field Change Request Form (Attachment C-2) and must be approved by the Port and EPA.

12.11.2 Laboratory Corrective Action

The analytical laboratories analyze samples according to specific methods with required QC standards. All analytical data are reviewed to ensure that the required QC measures have been taken and that all specified QC standards have been met. Some examples of situations that might require laboratory corrective action include the following:

- QC data are outside the control limit ranges for precision and accuracy established for laboratory samples;
- Blanks contain target analytes above acceptable levels;
- Deficiencies are detected by the laboratory QA director during internal or external audits, or from the results of performance evaluation samples;
- Undesirable trends are detected in QC data;
- There are unusual changes in detection limits; and/or
- Inquiries concerning data quality are received.

If the bench analyst identifies a QC violation, corrective action will be taken immediately. The analyst will notify his or her supervisor of the problem and the investigation being performed. Some examples of analyst-level corrective action can include the following:

- Recalculating mathematical calculations;
- Reanalyzing suspect samples; and/or
- Recalibrating analytical instruments.

If the problem persists or cannot be identified, the matter must be referred to the laboratory supervisor and QA/QC officer for further investigation. All laboratory QC problems that could affect the quality of the final data should be discussed with the Project Manager as part of the corrective action process. Some examples of managerial-level corrective action include the following:

- Evaluating and amending sub-sampling or analytical procedures;
- Resampling and analyzing new samples; and/or
- Qualifying or rejecting the data.

Once resolved, full documentation of the corrective action must be included with the applicable data package prior to submittal to the project manager. Any substantive changes that may affect data quality will be communicated with the Port and EPA.

12.12 Corrective Actions

If the quality control audit detects unacceptable conditions or data, the Project Manager will be responsible for developing and initiating corrective action. Corrective action may include the following:

- Reanalyzing the samples, if holding time criteria permit;
- Resampling and analyzing;
- Evaluating and amending sampling and analytical procedures; and
- Accepting data and acknowledging level of uncertainty or inaccuracy by flagging the data.

12.13 Laboratory Quality Assurance Review

A QA review will be conducted that presents a QA/QC evaluation of the data collected during the sampling activities for inclusion in the final report. In addition to an opinion regarding the validity of the data, the QA/QC evaluation will address the following:

- Any adverse conditions or deviations from the SAP/QAPP;
- Assessment of analytical data for precision, accuracy, and completeness evaluated based on criteria developed in this SAP/QAPP;
- Significant QA problems and recommended solutions; and
- Corrective actions taken for any problems previously identified.

12.14 Deviations

Any deviations from the Riverbank Characterization Work Plan and the accompanying SAP/QAPP will be communicated immediately with the EPA. The EPA Regional Project Manager (RPM) will be available to discuss deviations via cell phone or email and all deviations will be documented and approved using the *Field Change Request Form* in Attachment C-2.

12.15 Project Management Organization

Responsibilities of the team members, as well as laboratory project managers, are described below, and the relationships and lines of communication of project participants are presented in Attachment C-5:

- EPA Project Manager: Josie Clark –responsible for federal Superfund oversight of all project activities occurring at T4.
- DEQ Project Manager: Jeff Schatz – responsible for state Superfund oversight of all project activities occurring at T4 and other non-Superfund environmental regulatory compliance.
- Port of Portland Project Manager: Kelly Madalinski – responsible for ensuring compliance with the requirements of this SAP/QAPP.
- Project Manager (Apex Companies, LLC [Apex]): Steve Misner – Provides support for execution of Port responsibilities, responsible for reporting, coordinates subcontractor support, and manages the project schedule and budget.
- Quality Assurance/Quality Control (QA/QC) Manager (Apex): Kelsi Evans – Responsible for data quality review of plans, laboratory data reports, and data summary reports. Ensures integrity of data relative to data quality objectives and will ensure that the data is properly validated prior to use.

- Database Analyst (Apex): Megan Masterson – Responsible for loading field and laboratory analytical EDDs, performing database quality checks, updating the database as necessary, and comparing database records against laboratory hard copy reports.
- Site Safety and Health Officer (Apex): Steve Misner – Responsible for ensuring that physical and chemical hazards are appropriately mitigated through effective execution of the Sitewide Health and Safety Plan.
- Laboratory Data Manager (Apex Laboratories): Darrell Auvil – Client manager for the analytical laboratory contracted for the analysis of samples. Apex Laboratories is responsible for subcontracting samples to Bureau Veritas Laboratories and Analytical Resources Inc. The contract laboratories maintain a current certification from the National Environmental Laboratory Accreditation Program (NELAP) and the Oregon Environmental Laboratory Accreditation Program (ORELAP). Apex Laboratories is not affiliated with Apex Companies, LLC.
- Project Scientists, Engineers, and Technicians (Apex): Includes qualified geologists, chemists, engineers, and field technicians.

Table C-1
Analytical Program - Riverbank Soil
Terminal 4 Riverbank Characterization Work Plan
Portland, Oregon

Riverbank Area	Riverbank Cell	Unit	Sample Name	Sample Type	Judgmental Sample Target	Riverbank Soil COIs						Additional Analyses		
						TPH	PAHs	PCBs	Pesticides	Dioxins/ Furans	Metals	VOCs	Butyltins	Phthalates
Berth 401	1	Upper	T4RB-1U-OS	Judgmental	Outfall - Drainage Basin S	X		X		X				
			T4RB-1U	Archive	--									
		Lower	T4RB-1L	Probabilistic	--	X		X		X				
	2	Upper	T4RB-2U	Probabilistic	--	X		X		X				
		Lower	T4RB-2L	Probabilistic	--	X		X		X				
	3	Upper	T4RB-3U	Probabilistic	--	X		X		X				
		Lower	T4RB-3L	Probabilistic	--	X	X	X	X	X	X	X	X	X
	4	Upper	T4RB-4U-OR	Judgmental	Outfall - Drainage Basin R	X		X		X				
			T4RB-4U	Archive	--									
		Lower	T4RB-4L	Probabilistic	--	X		X		X				
	5	Upper	T4RB-5U	Probabilistic	--	X	X	X	X	X	X	X	X	X
		Lower	T4RB-5L	Probabilistic	--	X		X		X				
North Side of Slip 1	6	Upper	T4RB-6U	Probabilistic	--	X				X				
		Lower	T4RB-6L	Probabilistic	--	X				X				
	7	Upper	T4RB-7U	Probabilistic	--	X	X	X	X	X	X	X	X	X
		Lower	T4RB-7L	Probabilistic	--	X				X				
	8	Upper	T4RB-8U	Probabilistic	--	X				X				
		Lower	T4RB-8L	Probabilistic	--	X				X				
	9	Upper	T4RB-9U	Probabilistic	--	X				X				
		Lower	T4RB-9L	Probabilistic	--	X	X	X	X	X	X	X	X	X
	10	Upper	T4RB-10U	Probabilistic	--	X				X				
		Lower	T4RB-10L	Probabilistic	--	X				X				
	11	Upper	T4RB-11U	Probabilistic	--	X				X				
		Lower	T4RB-11L	Probabilistic	--	X				X				
Berth 405	12	Upper	T4RB-12U	Probabilistic	--	X		X		X				
		Lower	T4RB-12L	Probabilistic	--	X	X	X	X	X	X	X	X	X
	13	Upper	T4RB-13U	Probabilistic	--	X		X		X				
		Lower	T4RB-13L	Probabilistic	--	X		X		X				
	14	Upper	T4RB-14U	Probabilistic	--	X		X		X				
		Lower	T4RB-14L	Probabilistic	--	X		X		X				
	15	Upper	T4RB-15U	Probabilistic	--	X	X	X	X	X	X	X	X	X
		Lower	T4RB-15L	Archive	--									
			T4RB-15L-OQ	Judgmental	Outfall - Drainage Basin Q	X		X		X				

Please see notes at end of table.

Table C-1
Analytical Program - Riverbank Soil
Terminal 4 Riverbank Characterization Work Plan
Portland, Oregon

Riverbank Area	Riverbank Cell	Unit	Sample Name	Sample Type	Judgmental Sample Target	Riverbank Soil COIs						Additional Analyses		
						TPH	PAHs	PCBs	Pesticides	Dioxins/ Furans	Metals	VOCs	Butyltins	Phthalates
Berth 409	16	Upper	T4RB-16U	Probabilistic	--	X	X	X		X				
		Lower	T4RB-16L	Archive	--									
			T4RB-16L-O52C	Judgmental	Outfall - City Outfall 52C	X	X	X	X	X	X	X	X	X
			T4RB-16L-OO	Judgmental	Outfall - Drainage Basin O	X	X	X		X				
	17	Upper	T4RB-17U	Probabilistic	--	X	X	X	X	X	X	X	X	X
		Lower	T4RB-17L	Archive	--									
			T4RB-17L-ON	Judgmental	Outfall - Drainage Basin N	X	X	X		X				
Berth 408	18	Upper	T4RB-18U	Probabilistic	--	X	X	X		X	X			
		Lower	T4RB-18L	Archive	--									
			T4RB-18L-OM	Judgmental	Outfall - Drainage Basin M	X	X	X		X	X			
	19	Upper	T4RB-19U	Probabilistic	--	X	X	X		X	X			
		Lower	T4RB-19L	Probabilistic	--	X	X	X	X	X	X	X	X	X
	20	Upper	T4RB-20U	Probabilistic	--	X	X	X		X	X			
		Lower	T4RB-20L	Probabilistic	--	X	X	X		X	X			
	21	Upper	T4RB21U	Probabilistic	--	X	X	X	X	X	X	X	X	X
		Lower	T4RB-21L	Probabilistic	--	X	X	X		X	X			
	22	Upper	T4RB-22U	Probabilistic	--	X	X	X		X	X			
		Lower	T4RB-22L	Probabilistic	--	X	X	X		X	X			
South Side of Slip 1	23	Upper	T4RB-23U	Probabilistic	--	X	X	X	X	X	X			
		Lower	T4RB-23L	Probabilistic	--	X	X	X	X	X	X	X	X	X
	24	Upper	T4RB-24U	Probabilistic	--	X	X	X	X	X	X			
		Lower	T4RB-24L	Probabilistic	--	X	X	X	X	X	X			
	25	Upper	T4RB-25U	Probabilistic	--	X	X	X	X	X	X	X	X	X
		Lower	T4RB-25L	Probabilistic	--	X	X	X	X	X	X			
	26	Upper	T4RB-26U	Probabilistic	--	X	X	X	X	X	X			
		Lower	T4RB-26L	Probabilistic	--	X	X	X	X	X	X			
Riverside of Slip 1	27	Upper	T4RB-27U	Probabilistic	--	X								
		Lower	T4RB-27L	Probabilistic	--	X								
	28	Upper	T4RB-28U	Probabilistic	--	X	X	X	X	X	X	X	X	X
		Lower	T4RB-28L	Probabilistic	--	X								
	29	Upper	T4RB-29U	Probabilistic	--	X								
		Lower	T4RB-29L	Probabilistic	--	X								
Head of Slip 3	40	--	T4RB-K1	Judgmental	Outfall - Drainage Basin K1	X	X	X	X	X	X	X	X	X
		--	T4RB-K2	Judgmental	Outfall - Drainage Basin K2	X	X	X						
		--	T4RB-BEBRA	Judgmental	Erosion in BEBRA wall	X	X	X						
	41	--	T4RB-OJ	Judgmental	Outfall - Drainage Basin J	X	X	X						

Please see notes at end of table.

Table C-1
Analytical Program - Riverbank Soil
Terminal 4 Riverbank Characterization Work Plan
Portland, Oregon

Riverbank Area	Riverbank Cell	Unit	Sample Name	Sample Type	Judgmental Sample Target	Riverbank Soil COIs						Additional Analyses		
						TPH	PAHs	PCBs	Pesticides	Dioxins/ Furans	Metals	VOCs	Butyltins	Phthalates
Former Berth 412	43	Upper	T4RB-43U	Probabilistic	--	X	X				X			
		Lower	T4RB-43L	Probabilistic	--	X	X				X			
	44	Upper	T4RB-44U-OD1	Judgmental	Outfall - Drainage Basin D	X	X				X			
			T4RB-44U	Archive	--									
		Lower	T4RB-44L	Probabilistic	--	X	X	X	X	X	X	X	X	X
	45	Upper	T4RB-45U-OD2	Judgmental	Outfall - Drainage Basin D	X	X				X			
			T4RB-45U-OD3	Judgmental	Outfall - Drainage Basin D	X	X				X			
			T4RB-45U	Archive	--									
		Lower	T4RB-45L	Probabilistic	--	X	X				X			
	46	Upper	T4RB-46U	Probabilistic	--	X	X	X	X	X	X	X	X	X
		Lower	T4RB-46L	Probabilistic	--	X	X				X			
	47	Upper	T4RB-47U	Probabilistic	--	X	X				X			
		Lower	T4RB-47L	Probabilistic	--	X	X				X			
Riverside of Slip 3	48	Upper	T4RB-48U	Probabilistic	--	X	X							
		Lower	T4RB-48L	Probabilistic	--	X	X							
	49	Upper	T4RB-49U	Probabilistic	--	X	X							
		Lower	T4RB-49L	Probabilistic	--	X	X	X	X	X	X	X	X	X
	50	Upper	T4RB-50U	Probabilistic	--	X	X							
		Lower	T4RB-50L	Probabilistic	--	X	X							
	51	Upper	T4RB-51U	Probabilistic	--	X	X	X	X	X	X	X	X	X
		Lower	T4RB-51L	Probabilistic	--	X	X							
		Lower	T4RB-51L-OD4	Judgmental	Outfall - Drainage Basin D	X	X							
Quantity of Samples Collected and Analyzed				83		83	54	52	24	59	41	18	18	18

Notes:
1. TPH = Total petroleum hydrocarbons.
2. PAHs = Polycyclic aromatic hydrocarbons.
3. PCBs = Polychlorinated biphenyls.
4. VOCs = Volatile organic compounds.
5. COIs = Contaminants of interest.

Table C-2
Analytical Methods – Reporting Limit Goals
Terminal 4 Riverbank Characterization Work Plan
Portland, Oregon

Parameter	Method	Analytical Laboratory	Matrix: Riverbank Soil	Matrix: Sediment	Units	MDL	MRL	CUL	ROD RAL	ESD RAL	PTW	JSCS
Total Petroleum Hydrocarbons (TPH)												
TPH-Diesel	NWTPH-Dx	Apex Labs	X		mg/kg	10.0	20.0	91	--	--	--	--
TPH-Oil	NWTPH-Dx	Apex Labs	X		mg/kg	20.0	40.0	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Acenaphthene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	300
Acenaphthylene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	200
Anthracene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	845
Benz(a)anthracene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	1,050
Benzo(a)pyrene	EPA 8270E	Apex Labs	X	X	µg/kg	2.00	4.00	--	--	--	--	1,450
Benzo(b)fluoranthene	EPA 8270E	Apex Labs	X	X	µg/kg	2.00	4.00	--	--	--	--	--
Benzo(k)fluoranthene	EPA 8270E	Apex Labs	X	X	µg/kg	2.00	4.00	--	--	--	--	13,000
Benzo(b+k)fluoranthene(s)	EPA 8270E	Apex Labs	X	X	µg/kg	4.00	8.00	--	--	--	--	--
Benzo(g,h,i)perylene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	300
Chrysene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	1,290
Dibenzo(a,h)anthracene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	1,300
Fluoranthene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	2,230
Fluorene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	536
Indeno(1,2,3-cd)pyrene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	100
2-Methylnaphthalene	EPA 8270E	Apex Labs	X	X	µg/kg	2.67	5.33	--	--	--	--	200
Naphthalene	EPA 8270E	Apex Labs	X	X	µg/kg	2.67	5.33	--	--	--	140,000	561
Phenanthrene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	1,170
Pyrene	EPA 8270E	Apex Labs	X	X	µg/kg	1.33	2.67	--	--	--	--	1,520
Total PAHs	Calculated	--	X	X	µg/kg	4.00	8.00	23,000	13,000	30,000	--	--
cPAHs (BaP eq)	Calculated	--	X	X	µg/kg	--	--	85	--	--	106,000	--
Polychlorinated Biphenyl Aroclors (PCBs)												
Aroclor 1016	EPA 8082A	Apex Labs	X		µg/kg	2.00	4.00	--	--	--	--	530
Aroclor 1221	EPA 8082A	Apex Labs	X		µg/kg	2.00	4.00	--	--	--	--	--
Aroclor 1232	EPA 8082A	Apex Labs	X		µg/kg	2.00	4.00	--	--	--	--	--
Aroclor 1242	EPA 8082A	Apex Labs	X		µg/kg	2.00	4.00	--	--	--	--	--
Aroclor 1248	EPA 8082A	Apex Labs	X		µg/kg	2.00	4.00	--	--	--	--	1,500
Aroclor 1254	EPA 8082A	Apex Labs	X		µg/kg	2.00	4.00	--	--	--	--	300
Aroclor 1260	EPA 8082A	Apex Labs	X		µg/kg	2.00	4.00	--	--	--	--	200
Aroclor 1262	EPA 8082A	Apex Labs	X		µg/kg	2.00	4.00	--	--	--	--	--
Aroclor 1268	EPA 8082A	Apex Labs	X		µg/kg	2.00	4.00	--	--	--	--	--
Total PCBs	Calculated	--	X		µg/kg	2.00	4.00	9	75	--	200	0.39
Polychlorinated Biphenyl Congeners (PCBs)												
PCB 1 to PCB 209	EPA 1668A	BV Labs	X [12]	X	µg/kg	0.005 - 0.049	0.01 - 0.06	--	--	--	--	--
Total PCBs	Calculated	--	X [12]	X	µg/kg	--	--	9	75	--	200	0.39

Please see notes at end of table.

Table C-2
Analytical Methods – Reporting Limit Goals
Terminal 4 Riverbank Characterization Work Plan
Portland, Oregon

Parameter	Method	Analytical Laboratory	Matrix		Units	MDL	MRL	CUL	ROD RAL	ESD RAL	PTW	JSCS
			Riverbank Soil	Sediment								
Dioxins/Furans												
2,3,7,8 TCDD	EPA 1613B	BV Labs	X	X	pg/g	0.111	1.0	0.2	0.6	--	10	0.0091
1,2,3,7,8 PeCDD	EPA 1613B	BV Labs	X	X	pg/g	0.105	5.0	0.2	0.8	--	10	2.6
1,2,3,4,7,8 HxCDD	EPA 1613B	BV Labs	X	X	pg/g	0.097	5.0	--	--	--	--	--
1,2,3,6,7,8 HxCDD	EPA 1613B	BV Labs	X	X	pg/g	0.094	5.0	--	--	--	--	--
1,2,3,7,8,9 HxCDD	EPA 1613B	BV Labs	X	X	pg/g	0.09	5.0	--	--	--	--	--
1,2,3,4,6,7,8 HpCDD	EPA 1613B	BV Labs	X	X	pg/g	0.098	5.0	--	--	--	--	690
OCDD	EPA 1613B	BV Labs	X	X	pg/g	0.146	10.0	--	--	--	--	23,000
2,3,7,8 TCDF	EPA 1613B	BV Labs	X	X	pg/g	0.100	1.0	0.40658	--	--	600	0.77
1,2,3,7,8 PeCDF	EPA 1613B	BV Labs	X	X	pg/g	0.092	5.0	--	--	--	--	2.6
2,3,4,7,8 PeCDF	EPA 1613B	BV Labs	X	X	pg/g	0.101	5.0	0.3	200	--	200	0.03
1,2,3,4,7,8 HxCDF	EPA 1613B	BV Labs	X	X	pg/g	0.111	5.0	0.4	--	--	40	2.7
1,2,3,6,7,8 HxCDF	EPA 1613B	BV Labs	X	X	pg/g	0.087	5.0	--	--	--	--	2.7
2,3,4,6,7,8 HxCDF	EPA 1613B	BV Labs	X	X	pg/g	0.099	5.0	--	--	--	--	2.7
1,2,3,7,8,9 HxCDF	EPA 1613B	BV Labs	X	X	pg/g	0.094	5.0	--	--	--	--	2.7
1,2,3,4,6,7,8 HpCDF	EPA 1613B	BV Labs	X	X	pg/g	0.092	5.0	--	--	--	--	690
1,2,3,4,7,8,9 HpCDF	EPA 1613B	BV Labs	X	X	pg/g	0.087	5.0	--	--	--	--	690
OCDF	EPA 1613B	BV Labs	X	X	pg/g	0.108	10.0	--	--	--	--	23,000
Total TEQ	Calculated	--	X	X	pg/g	0.327	--	10	--	--	--	--
Organochlorine Pesticides												
Aldrin	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	2	--	--	--	40
gamma-BHC (Lindane)	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	5	--	--	--	4.99
Chlordane (Technical)	EPA 8081B	Apex Labs	X		µg/kg	15.0	30.0	--	--	--	--	--
cis-Chlordane	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
trans-Chlordane	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
Oxychlordane	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
2,4'-DDD	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
2,4'-DDE	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
2,4'-DDT	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
4,4'-DDD	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
4,4'-DDE	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
4,4'-DDT	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
Dieldrin	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	0.07	--	--	--	0.0081
Endosulfan I	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
Endosulfan II	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
Endosulfan sulfate	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
cis-Nonachlor	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	--
trans-Nonachlor	EPA 8081B	Apex Labs	X		µg/kg	0.500	1.00	--	--	--	--	0.37

Please see notes at end of table.

Table C-2
Analytical Methods – Reporting Limit Goals
Terminal 4 Riverbank Characterization Work Plan
Portland, Oregon

Parameter	Method	Analytical Laboratory	Matrix: Riverbank Soil	Matrix: Sediment	Units	MDL	MRL	CUL	ROD RAL	ESD RAL	PTW	JSCS
Organochlorine Pesticides Continued												
Total Chlordanes	Calculated	--	X		µg/kg	0.500	1.00	1.4	--	--	--	0.33
DDD	Calculated	--	X		µg/kg	0.500	1.00	114	--	--	--	0.33
DDE	Calculated	--	X		µg/kg	0.500	1.00	50	--	--	--	0.33
DDT	Calculated	--	X		µg/kg	0.500	1.00	246	--	--	--	0.33
DDx	Calculated	--	X		µg/kg	0.500	1.00	6.1	160	--	7,050	--
Analysis Contingent on EPA Method 8081 Result												
Dieldrin	EPA 1699	BV Labs	X [12]		µg/kg	0.050	0.0076	0.07	--	--	--	0.0081
Metals												
Arsenic	EPA 6020A	Apex Labs	X		mg/kg	0.250	0.500	3	--	--	--	7
Cadmium	EPA 6020A	Apex Labs	X		mg/kg	0.0500	0.100	0.51	--	--	--	4.98
Copper	EPA 6020A	Apex Labs	X		mg/kg	0.250	0.500	359	--	--	--	149
Lead	EPA 6020A	Apex Labs	X		mg/kg	0.0500	0.100	196	--	--	--	17
Mercury	EPA 6020A	Apex Labs	X		mg/kg	0.0200	0.0400	0.085	--	--	--	0.07
Zinc	EPA 6020A	Apex Labs	X		mg/kg	1.00	2.00	459	--	--	--	459
Volatile Organic Compounds (VOCs)												
Chlorobenzene	EPA 8260C	Apex Labs	X		µg/kg	12.5	25.0	--	--	--	320	--
Butyl Tins												
Tributyltin Ion	EPA 8270D-SIM	ARI	X		µg/kg	0.450	3.86	3,080	--	--	--	2.3
Phthalates												
Bis(2-ethylhexyl)phthalate (BEHP)	EPA 8270E	Apex Labs	X		µg/kg	20.0	40.0	135	--	--	--	330
Conventional Parameters												
Grain Size	ASTM D422 mod	Apex Labs		X	--	--	--	--	--	--	--	--
Gravel (>2.00mm)					%	0.0100	0.0100	--	--	--	--	--
Sand (0.063mm - 2.00mm)					%	0.0100	0.0100	--	--	--	--	--
Silt (0.005mm < 0.063mm)					%	0.0100	0.0100	--	--	--	--	--
Clay (< 0.005 mm)					%	0.0100	0.0100	--	--	--	--	--
% Retained 4.75 mm sieve (#4)					%	0.0100	0.0100	--	--	--	--	--
% Retained 2.00 mm sieve (#10)					%	0.0100	0.0100	--	--	--	--	--
% Retained 0.85 mm sieve (#20)					%	0.0100	0.0100	--	--	--	--	--
% Retained 0.425 mm sieve (#40)					%	0.0100	0.0100	--	--	--	--	--
% Retained 0.250 mm sieve (#60)					%	0.0100	0.0100	--	--	--	--	--
% Retained 0.150 mm sieve (#100)					%	0.0100	0.0100	--	--	--	--	--
% Retained 0.106 mm sieve (#140)					%	0.0100	0.0100	--	--	--	--	--
% Retained 0.075 mm sieve (#200)					%	0.0100	0.0100	--	--	--	--	--
% Retained 0.063 mm sieve (#230)					%	0.0100	0.0100	--	--	--	--	--
Total Solids	SM 2540G	Apex Labs		X	%	1.00	1.00	--	--	--	--	--
Total Organic Carbon	EPA 9060A	Apex Labs		X	mg/kg	200	200	--	--	--	--	--

Notes:

1. µg/kg = Micrograms per kilogram.
2. mg/kg = Milligrams per kilogram.
3. pg/g = Picograms per gram.
4. MDL = Method detection limit.
5. MRL = Minimum reporting limit.
6. Calculated parameters will be calculated following Appendix A of the Portland Harbor RI/FS (2016).
7. CUL = Cleanup Levels from the Portland Harbor Superfund Site Record of Decision for Riverbank Soil, Table 17 January 2020 Errata #2 update, (ROD, 2017).
8. ROD RAL = Remedial Action Levels from the Portland Harbor Superfund Site ROD (2017).
9. ESD RAL = Remedial Action Levels from the Portland Harbor Superfund Site Explanation of Significant Differences (ESD, 2019).
10. PTW = Principal Threat Waste threshold from the Portland Harbor Superfund Site ROD (2017).
11. JSCS = Joint Source Control Strategy Screening Level Values (DEQ/EPA, 2005)
12. Analysis contingent on initial results. See section 7.1.1 of the SAP/QAPP.

Table C-3
Analytical Program - Sediment
Terminal 4 Riverbank Characterization Work Plan
Portland, Oregon

Station ID	Northing	Easting	Sample ID	PAHs	PCBs	Grain Size	Total Solids	TOC	Dioxins/ Furans	Archive
SG04	713072.13	7619832.56	SG04a							X
			SG04b							X
			SG04c							X
			SG04	X	X	X	X	X	X	X
SG05	713062.20	7619991.61	SG05a							X
			SG05b							X
			SG05c							X
			SG05	X	X	X	X	X		X
SG06	713054.46	7620136.08	SG06a							X
			SG06b							X
			SG06c							X
			SG06	X	X	X	X	X		X
SG07	713046.50	7620289.70	SG07a							X
			SG07b							X
			SG07c							X
			SG07	X	X	X	X	X	X	X

Notes:

1. PAHs = Polycyclic aromatic hydrocarbons.
2. PCBs = Polychlorinated biphenyls (congeners).
3. TOC = Total organic carbon.
4. Sediment surface samples will be collected at a target depth of 0 to 30 centimeters below mudline. Sampling depth may be adjusted based on recovery.
5. Coordinate data in NAD83 international feet.

Table C-4
Analytical Methods – Sample Container Requirements
Terminal 4 Riverbank Characterization Work Plan
Portland, Oregon

Analysis	Preparation Method	Analysis Method	Container	Storage Temperature	Holding Time	
					Sampling to Preparation	Preparation to Analysis
TPH	NWTPH-Dx	NWTPH-Dx	4-oz glass jar	4±2 C	14 days	40 days
Metals	EPA 3051A	EPA 6020A	4-oz glass jar	4±2 C	180 days	
Mercury	EPA 3051A	EPA 6020A		4±2 C	28 days	
Grain Size	ASTM D422 mod	ASTM D422 mod	16-oz glass jar	4±2 C	None	
VOCs	EPA 5035A	EPA 8260D	40 mL Terracore with Methanol/2-oz glass jar	4±2 C	14 days	
PAHs/Phthalates	EPA 3546	EPA 8270E	4-oz glass jar	4±2 C	14 days	40 days
				-18 C	1 year	40 days
PCB Aroclors	EPA 3546	EPA 8082A	4-oz glass jar	4±2 C	None	
				-18 C		
Organochlorine Pesticides	EPA 3546	EPA 8081B	4-oz glass jar	4±2 C	14 days	40 days
				-18 C	1 year	40 days
Tributyltin	EPA 3550C	EPA 8270D-SIM	4-oz glass jar	4±2 C	14 days	40 days
				-18 C	1 year	40 days
Dioxins/Furans	EPA 1613, OR EZ123	EPA 1613B	4-oz glass jar	4±2 C	None	
				-18 C		
PCB Congeners	EPA 1668C	EPA 1668A	4-oz glass jar	4±2 C	None	
				-18 C		
Dieldrin	EPA 1669	EPA 1699	4-oz glass jar	4±2 C	14 days	40 days
				-18 C	1 year	40 days
Total Organic Carbon	PSEP/EPA 5310B	EPA 9060A	4-oz glass jar	4±2 C	28 days	
				-18 C	180 days	
Total Solids	SM 2540G	SM 2540G	2-oz glass jar	4±2 C	None	
				-18 C		
Archive Sample	--	--	8-oz glass jar	-18 C	90 days [11]	

Notes:

1. EPA = U.S. Environmental Protection Agency.
2. NWTPH = Northwest Total Petroleum Hydrocarbon method.
3. ASTM = American Society for Testing Materials.
4. SM = Standard Method.
5. PSEP = Puget Sound Estuary Program method.
6. TPH = Total petroleum hydrocarbons.
7. PAHs = Polycyclic aromatic hydrocarbons.
8. PCBs = Polychlorinated biphenyls.
9. C = Degrees Celsius.
10. oz = ounce.
11. Archive samples will be held by Apex Labs for an initial 90 days. Additional extensions may be necessary and will be communicated with the Port, DEQ, and EPA.

Table C-5
Analytical Data Measurement Performance Criteria
Terminal 4 Riverbank Characterization Work Plan
Portland, Oregon

Analysis	Matrix	Precision (Duplicate RPD)	Accuracy (Analyte Recovery)	Completeness
Grain Size	Sediment	--	--	95%
Total Solids	Sediment/Riverbank Soil	20%	--	95%
TOC	Sediment	25%	70% to 130%	95%
Organochlorine Pesticides	Riverbank Soil	35%	50% to 150%	95%
PCB Aroclors	Riverbank Soil	35%	50% to 150%	95%
PCB Congeners	Sediment	35%	50% to 150%	95%
PAHs	Sediment/Riverbank Soil	35%	50% to 150%	95%
Dioxins/Furans	Sediment/Riverbank Soil	35%	50% to 150%	95%
TPH	Riverbank Soil	35%	50% to 150%	95%
Metals	Riverbank Soil	35%	70% to 130%	95%
Mercury	Riverbank Soil	35%	70% to 130%	95%
VOCs	Riverbank Soil	35%	50% to 150%	95%
Tributyltin	Riverbank Soil	35%	50% to 150%	95%
Phthalates	Riverbank Soil	35%	50% to 150%	95%

Notes:

1. Accuracy control limits apply to the LCS/LCSD and MS/MSD only. For labeled compound recovery, method-specific control limits will be used. Surrogate control limits will be developed by the laboratory.
2. Precision control limits apply to analytical batch pairs (LCS/LCSD and MS/MSD) and laboratory duplicates. The RPD control limit for field duplicates is 50%.
3. The RPD for results greater than five times the reporting limit must be less than indicated in the table. For results that are less than five times the reporting limit, the absolute difference between the two results must be less than ±2 times the reporting limit.
4. -- = Not applicable.
5. RPD = Relative percent difference as calculated using the equation in section 11.1.1 of the SAP/QAPP.
6. Analyte recovery as calculated using the equation in section 11.1.3 of the SAP/QAPP.
7. TOC = Total organic carbon.
8. PCBs = Polychlorinated biphenyls.
9. PAHs = Polycyclic aromatic hydrocarbons.
10. TPH = Total petroleum hydrocarbons.
11. VOCs = Volatile organic compounds.

Table C-6
Quality Control Sample Analysis Frequency
Terminal 4 Riverbank Characterization Work Plan
Portland, Oregon

Analysis	Analytical Method	Equipment Blank	Field Duplicate	Instrument Calibration	Initial Calibration Verification	Continuing Calibration Verification	Instrument Performance Check	Calibration Blank	Method Blank	Laboratory Duplicate [10]	Laboratory Control Sample	Laboratory Control Sample Duplicate [10]	Matrix Spike	Matrix Spike Duplicate [10]	Surrogate
Grain Size	ASTM D422 mod	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Solids	SM 2540G	--	--	Each batch	Each batch	Every 10 samples	--	--	1 per 20 samples	1 per 20 samples	--	--	--	--	--
TOC	EPA 9060A	--	1 per 20 samples	As needed	Daily	Every 10 samples	--	Every 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	--
Organochlorine Pesticides	EPA 8081B	1 per 20 samples	1 per 20 samples	As needed	Daily	Every 10 samples	--	Every 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Dieldrin	EPA 1699	1 per 20 samples	1 per 20 samples	As needed	Daily	Every 12 hours	Daily	Every 12 hours	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	--	--	Every sample
PCB Aroclors	EPA 8082A	1 per 20 samples	1 per 20 samples	As needed	Daily	Every 10 samples	--	Every 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
PCB Congeners	EPA 1668A	1 per 20 samples	1 per 20 samples	As needed	Daily	Every 12 hours	Daily	Every 12 hours	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	--	--	Every sample
PAHs/Phthalates	EPA 8270E	1 per 20 samples	1 per 20 samples	As needed	Daily	Every 12 hours	Daily	Every 12 hours	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Dioxins/Furans	EPA 1613B	1 per 20 samples	1 per 20 samples	As needed	Daily	Every 12 hours	Daily	Every 12 hours	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	--	--	Every sample
TPH	NWTPH-Dx	1 per 20 samples	1 per 20 samples	As needed	Daily	Every 10 samples	--	Every 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Metals/Mercury	EPA 6020A	1 per 20 samples	1 per 20 samples	Daily	Daily	Every 10 samples	Daily	Every 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
VOCs	EPA 8260C	1 per 20 samples	1 per 20 samples	As needed	Daily	Every 12 hours	Daily	Every 12 hours	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Tributyltin	EPA 8270D-S M	1 per 20 samples	1 per 20 samples	As needed	Daily	Every 12 hours	Daily	Every 12 hours	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample

Notes:

1. EPA = U.S. Environmental Protection Agency.
2. NWTPH = Northwest Total Petroleum Hydrocarbon method.
3. ASTM = American Society for Testing Materials.
4. SM = Standard Method.
5. TOC = Total organic carbon.
6. PCBs = Polychlorinated biphenyls.
7. PAHs = Polycyclic aromatic hydrocarbons.
8. TPH = Total petroleum hydrocarbons.
9. VOCs = Volatile organic compounds.
10. Duplicate analysis (precision) may be achieved with a field duplicate, laboratory duplicate, laboratory control sample duplicate, and/or matrix spike duplicate.

Attachment C-1

Surface Soil Sampling Standard Operating Procedures

1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes the methods used for obtaining surface soil samples for physical and/or chemical analysis. For purposes of this SOP, surface soil (including shallow subsurface soil) is loosely defined as soil that is present within 3 feet of the ground surface at the time of sampling. Various types of sampling equipment are used to collect surface soil samples including spoons, scoops, trowels, shovels, and hand augers.

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Spoons, scoops, trowels, shovels, and/or hand augers. Stainless steel is preferred.
- Stainless steel bowls
- Laboratory-supplied sample containers
- Field documentation materials
- Decontamination materials
- Personal protective equipment (as required by Health and Safety Plan)

3. METHODOLOGY

Project-specific requirements will generally dictate the preferred type of sampling equipment used at a particular site. The following parameters should be considered: sampling depth, soil density, soil moisture, use of analyses (e.g., chemical versus physical testing), type of analyses (e.g., volatile versus non-volatile). Analytical testing requirements will indicate sample volume requirements that also will influence the selection of the appropriate type of sampling tool. The project sampling plan should define the specific requirements for collection of surface soil samples at a particular site.

Collection of Samples

- Volatile Analyses. Surface soil sampling for volatile organics analysis (VOA) is different than other routine physical or chemical testing because of the potential loss of volatiles during sampling. To limit volatile loss, the soil sample must be obtained as quickly and as directly as possible. If a VOA sample is to collected as part of a multiple analyte sample, the VOA sample portion will be obtained first. The VOA sample should be obtained from a discrete portion of the entire collected sample and should not be composited or homogenized. Sample bottles should be filled to capacity, with no headspace. Specific procedures for collecting VOA samples using the EPA Method 5035 are discussed in SOP 2-7.

- Other Analyses. Once the targeted sample interval has been collected, the soil sample will be thoroughly homogenized in a stainless steel bowl prior to bottling. Sample homogenizing is accomplished by manually mixing the entire soil sample in the stainless steel bowl with the sampling tool or with a clean teaspoon or spatula until a uniform mixture is achieved. If packing of the samples into the bottles is necessary, a clean stainless steel teaspoon or spatula may be used.

General Sampling Procedure:

- Decontaminate sampling equipment in accordance with the Sampling and Analysis Plan (SAP) before and after each individual soil sample.
- Remove surface debris that blocks access to the actual soil surface or loosen dense surface soils, such as those encountered in heavy traffic areas. If sampling equipment is used to remove surface debris,

the equipment should be decontaminated prior to sampling to reduce the potential for sample interferences.

- When using a hand auger, push and rotate downward until the auger becomes filled with soil. Usually a 6- to 12-inch long core of soil is obtained each time the auger is inserted. Once filled, remove the auger from the ground and empty into a stainless steel bowl. If a VOA sample is required, the sample should be taken directly from the auger using a teaspoon or spatula and/or directly filling the sample container from the auger. Repeat the augering process until the desired sample interval has been augered and placed into the stainless steel bowl.

Backfilling Sample Locations:

Backfill in accordance with federal and state regulations including OAR 690-240 (e.g., bentonite requirements). The soils from the excavation will be used as backfill unless project-specific or state requirements include the use of clean backfill material.

Attachment C-2

Field Forms

APEX

3015 SW First Avenue
Portland, Oregon 97201-4707
(503) 924-4704 Phone
(503) 943-6357 Fax

PROJECT NUMBER ______
FIELD REPORT NUMBER ______
PAGE ______ OF ______
DATE ______

PROJECT ______
LOCATION ______
CLIENT ______
ARRIVAL TIME ______
DEPARTURE TIME ______
WEATHER ______
PURPOSE OF OBSERVATIONS ______
APEX REPRESENTATIVE ______
CONTRACTOR ______
CONTRACTOR REP. ______
APEX PROJECT MANAGER ______
PERMIT NO. ______
H&S REVIEW ______

Our firm's professionals are represented on site solely to observe operations of the contractor identified, to form opinions about the adequacy of those operations, and to report those opinions to our client. The presence and activities of our field representative do not relieve any contractor from its obligation to meet contractual requirements. The contractor retains sole responsibility for site safety and the methods, operations, send sequence of construction. Unless signed by the Ash Creek Associates Project Manager, this report is preliminary. A preliminary report is provided solely as evidence that field observation was performed. Observations and/or conclusions and/or recommendations conveyed in the final report may vary from and shall take precedence over those included in a preliminary report.

BY

APEX REPRESENTATIVE

REVIEWED BY

APEX PROJECT MANAGER

Field Audit Checklist

APEX
3015 SW First Avenue
Portland, Oregon 97201-4707
(503) 924-4704 Phone
(503) 943-6357 Fax

Project Number: ____________________
Project Name: ____________________
Project Location: ____________________
Client: ____________________
Project Manager: ____________________
Field Audit Number: ____________________
Page __________ of __________

Field Auditor Name: ____________________ Date: ____________________

Item to be Evaluated	Yes	No	N/A	Comments
Part 1: Record Keeping				
Are there SOPs for field activities and are they accessible to everyone on the sampling team?				
Are COC forms filled out completely and legibly using black, waterproof ink?				
Are all errors in documentation correctedand initiated without obliteration?				
Part 2: Safety				
Is the Heatlh and Safety Plan on site?				
Are tailgate safety meetings being conducted at the beginning of each work day and when site conditions change?				
Is there documentation that everyone on the sampling team has read and understands the HASP?				
Does the HASP include emergency contact information and the route to hospital?				
Are proper lifting techniques being used?				
Is the correct PPE being worn?				
Are gloves being worn when collecting and/or handling samples?				
Are new gloves being used for each sample collected?				
Are proper procedures being followed when operating equipment with moving or rotating parts?				
Are the proper tools being used for sampling?				
Are proper procedures being followed when working in confined spaces?				
Are all injuries or accidents being reported immediately to the appropriate supervisor?				
Are all traffic laws and posted signs being obeyed?				

APEX
3015 SW First Avenue
Portland, Oregon 97201-4707
(503) 924-4704 Phone
(503) 943-6357 Fax

Field Audit Checklist Continued

Project Number: ____________________

Project Name: ____________________

Page ______ of ______

Date: ____________________

Item to be Evaluated	Yes	No	N/A	Comments
Part 3: Sampling Equipment				
Is the correct sampling equipment being used for the project?				
Is the sampling equipment inspected before use and repaired/replaced when needed?				
Is the sampling equipment properly cleaned before each use following decontamination procedures in the SAP?				
Is the sampling equipment properly stored when not in use?				
Is an equipment blank being performed?				
Part 4: Sampling				
Are sample containers the correct material, correct size, in good condition and contain the correct preservation?				
Are samples collected for all required analyses?				
Are samples being collected using the appropriate sampling method?				
Is care taken to avoid sample contamination?				
Part 5: Sample Handling				
Are samples uniquely identified to ensure no confusion regarding identity of such samples at any time?				
Are samples placed on ice immediately after collection?				
Are samples recorded on the chain-of-custody form immediately following collection?				
Are samples stored and transported on ice?				
Are samples protected from breakage and cross-contamination during transport?				
Are samples shipped in a timely manner?				

Additional Notes:

APEX
3015 SW First Avenue
Portland, Oregon 97201-4707
(503) 924-4704 Phone
(503) 943-6357 Fax

FIELD CHANGE REQUEST FORM

PROJECT NUMBER ____________________

FIELD REPORT NUMBER ____________________

PAGE __________ OF __________

DATE ____________________

PROJECT ____________________ APEX PROJECT MANAGER ____________________

LOCATION ____________________ CLIENT ____________________

Description of modification:

Reason for modification:

Reference to Work Plan/SAP/QAPP (pg # and section):

REVIEW AND APPROVAL

Review comments:

Approval documentation:

__________ Port (email or phone) Date: __________ Port Personnel: __________

__________ EPA (email) Date: __________ EPA Personnel: __________

Approval comments/notes:

EPA APPROVAL MUST BE RECEIVE IN WRITING (EMAIL) PRIOR TO IMPLEMENTING CHANGES TO THE SOW

Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

Project:

Project Number:

Logged By:

Date:

Site Conditions:

Drilling Contractor:

Drilling Equipment:

Sampler Type:

Depth to Water (ATD):

Surface Elevation:

Sample Details and Notes:

Depth, centimeters	Core nterva /Recovery	Laboratory Samp e D	P D	Sheen	Material Description	Sample Details and Notes
30						30
30						30
30						30
30						30
30						30
30						30

Attachment C-3

Laboratory Standard Operating Procedures

Document Number	Revision Number	Document Title
D-007	R-00	APEX Travel Policy
D-008	R-00	Apex Illness Management Directive
E-001	R-08	Microwave Extraction of Semivolatile Organic Compounds by EPA Method 3546
E-002	R-05	Toxic and Hazardous Waste Leaching Procedures
E-003	R-06	Separatory Funnel Liquid-Liquid Extraction of Semivolatile Organic Compounds by EPA Method 3510C
E-004	R-03	Post Extraction of Organic Extracts
E-005	R-04	GPC (gel permeation chromatography) Cleanup of Organic Extracts
E-007	R-03	Semi-volatile Organic Compounds in Water by Microextraction
F-001	R-08	Analysis of Semi-volatile Petroleum Products by EPA NWTPH-Dx and EPA 8015 (Cal. LUFT)
F-002	R-09	Hydrocarbon Identification (HCID) by NWTPH-HCID
F-003	R-05	N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry
G-101	R-03	Grain-Size Analysis of Soils (Full Grain-Size method with hydrometer readings)
G-104	R-01	Grain-Size Analysis of Soils (Aggregates, Sieve only)
G-105	R-01	Representative Sampling Methodology (RSM)
L-001	R-04	Sample Receipt, Login, Subsampling, and Subcontracting
L-002	R-03	Sample Bottle Receipt, Preparation, and Bottle Orders
L-003	R-03	Sample Management and Waste Disposal
L-004	R-03	Courier Procedures
L-005	R-00	Foreign Sample Management and Waste Disposal
L-101	R-05	Verification of Thermometer Calibrations
L-102	R-06	Temperature Control Systems
L-104	R-03	Balance Calibration and Maintenance
L-107	R-04	Volumetric Measurement
M-001	R-08	Determination of Trace Metals by ICP-MS
M-004	R-00	Mercury by CVAF
M-101	R-07	Microwave Digestion of Sediments, Sludges, and Soils for Metals Analysis
M-102	R-06	Microwave Digestion of Aqueous Samples for Metals Analysis
P-001	R-04	Determination of MDLs, Detection Limits, and Reporting Limits
P-002	R-04	Proficiency Test Documentation
P-003	R-04	Spike and Duplicate Policy
P-004	R-03	Standards, Consumables, and Reference Materials
P-007	R-03	Establishing Control Limits and Control Charting
P-008	R-04	Manual Integrations
P-009	R-04	Prevention of Sample Switches and Sample Switch Data Correction

P-010	R-05	Data Assessment and Qualification for Blank Detection
P-012	R-03	Cyanide Sampling, Preservation, and Interference Mitigation for Water Samples
P-013	R-03	Subcontract Laboratory Policy
P-015	R-02	Hazardous and Weird Sample Plans
P-016	R-00	Data Investigations at Client Request
P-019	R-01	Temperature Exceedances
Q-001	R-08	Quality Systems Manual
Q-002	R-06	Safety Manual and Chemical Hygiene Plan
Q-003	R-01	Document Control and Record Keeping Manual
Q-101	R-07	Code of Ethics and Data Integrity
Q-103	R-04	Orientation & Training
Q-104	R-04	Calibration, Data, and Report Generation Review
Q-106	R-04	Management Review
Q-107	R-05	Demonstrations of Capability
Q-108	R-02	New Method Development and Validation
Q-109	R-02	Project Management
Q-110	R-03	Internal Audits
S-002	R-08	Analysis of Polychlorinated Biphenyls (PCBs) by GC/ECD
S-003	R-09	Analysis of Organochlorine Pesticides by GC/ECD
S-004	R-07	Analysis of Selected Semi-volatile Organic Compounds by GC-MS
V-001	R-09	Analysis of Volatile Organic Compounds by EPA Method 8260B
V-002	R-09	Analysis of Volatile Organic Compounds by WA DOE NWTPH-Gx, 8015M and California LUFT
V-003	R-02	Analysis of Volatile Organic Compounds by Gas Chromatography / Mass Spectrometry
W-001	R-08	pH Determination in Aqueous and Solid Matrices
W-004	R-07	Determination of Fluoride by Ion-Selective Electrode (ISE)
W-005	R-08	Conductivity by Probe
W-008	R-04	Biochemical Oxygen Demand (5 day) by Standard Methods 5210B
W-009	R-06	Nephelometric Turbidity
W-010	R-05	Chemical Oxygen Demand (COD), Manual Colorimetric Method
W-011	R-07	Determination of Alkalinity by Titration
W-012	R-06	Colorimetric Determination of Total & Dissolved Reactive Phosphorous Using Ascorbic Acid
W-014	R-08	Determination of Cyanide: Total, Amenable and Weak Acid Dissociable Micro Distillation/Colorimetry
W-018	R-05	Flash Point by Pensky-Martens Closed Cup Tester
W-019	R-06	Determination of Free Cyanide in Water and Wastewater by Microdiffusion
W-020	R-06	Nitrate-Nitrite as Nitrogen by EPA 353.2
W-022	R-07	Solids, Residue, and Percent Moisture
W-023	R-04	Alkaline Digestion and Colorimetric Determination of Hexavalent Chromium in Soil

W-024	R-06	Total Organic Carbon in Solids
W-025	R-04	Ammonia as Nitrogen in Sediment and Soil
W-026	R-02	Fluoride - Bellack Distillation
W-027	R-05	Determination of Free Cyanide with Flow Analysis, Gas Diffusion Separation, and Amperometric Detection
W-028	R-03	Colorimetric Analysis of Hexavalent Chromium in Water
W-029	R-04	Determination of Available Cyanide by Ligand Exchange, Gas Diffusion, and Amperometric Detection
W-030	R-06	Determination of Total Cyanide by Flow Analysis, UV digestion, Gas Diffusion, and Amperometric Detection
W-031	R-03	Sediment Concentrations in Water Samples by ASTM D3977 Test Method B (filtration)
W-032	R-03	Paint Filter Free Liquids Test
W-034	R-04	Determination of Percent Dry Weight
W-036	R-05	Aqueous Total Organic Carbon
W-037	R-03	In-line Gas Diffusion Ammonia, by Gas Diffusion Segmented Flow Analysis
W-039	R-03	Determination of Silica by Spectrophotometer
W-041	R-02	Total Residual Chlorine by DPD Colorimetric Method
W-042	R-01	Enzyme Substrate Coliform Tests Using IDEXX Technology
W-043	R-01	Dissolved Oxygen by Probe (Modified)
W-044	R-01	Determination of Total Kjeldahl Nitrogen by Block Digestion and Gas Diffusion Segmented Flow Analysis
W-101	R-07	Determination of Inorganic Anions by Ion Chromatography
Z-001	R-02	Detailed Identification and Characterization of Low, Medium and High Boiling Materials by ASTM D2887-14M
Z-002	R-01	Detailed Identification and Characterization of Low Boiling Materials, Including Automotive Gasoline, Aviation Gasoline and Other Light End Products by ASTM D7096-10M
Z-003	R-01	Detailed Hydrocarbon Analysis (DHA or PIANO) of Gasoline and Other Low Boiling Products by ASTM D6730-01M
Z-004	R-00	Organic Lead and Manganese Speciation in Gasoline and Gasoline in soil by GC/ECD

Table 5.5.13-1 Summary of Support Equipment Calibration and Maintenance			
Instrument	**Activity**	**Frequency**	**Documentation**
Balance	1. Clean 2. Check alignment 3. Service Contract	1. Before use 2. Before use 3. Annually	Worksheet/log book Post annual service date on balance and in Element.
Working Standard Weights	1. Only use for the intended purpose 2. Use plastic forceps or gloves to handle 3. Keep in case 4. Periodic calibration verification.	4. Annually.	Weight calibration log or certificate if done externally.
ASTM Class 1 Reference Weights	1. Only use for the intended purpose 2. Use plastic forceps or gloves to handle 3. Keep in case 4. Send out for calibration verification.	4. Every 5 years if weight is used only to check working standard weights which are then used for the daily checks.	Keep certificate
NIST Traceable Reference Thermometer	1. Send out for calibration verification.	1. Annually	Keep certificate
Working Thermometers:	Verify against reference thermometer	1. Annually 3. Daily for IR gun.	Calibration factor and date of calibration on thermometer and worksheet/log book
pH meters	Calibration: 1. Buffers used for calibration will bracket the pH of the media, reagent, or sample tested.	Before use	Worksheet.
pH probe	Use manufacturer's specifications	As needed	Worksheet/log book
photometer	1. Keep cells clean 2. Service Contract	2. Annually	Post service date on instrument and in maintenance log
Automatic or digital type pipettes	Calibrate for accuracy and precision using reagent water and analytical balance	Monthly	Worksheet/logbook
Volumetric lab ware	1. Class A lab ware is kept clean and in good condition. It is segregated from non-class A lab ware. 2. Non-class A lab ware	2. Once per manufacturers lot number.	Worksheet/logbook

Table 5.5.13-1 Summary of Support Equipment Calibration and Maintenance			
Instrument	**Activity**	**Frequency**	**Documentation**
	has its calibration verified using reagent water and an analytical balance		
Refrigerators, Freezers, and BOD incubators	1. Thermometers are immersed in liquid, sand, or glass beads for stability. 2. The thermometers are graduated in increments of 1°C or less	Temperatures are recorded each day in use	Worksheet/log book
Traceable Clock	Local computer clocks synced with server, which is synced with internet time service.	Daily	Server logs
Sterilizer	1. Use chemical indicator strip placed in center of load to verify sterilizer effectiveness. 2. Biological Indicator test kit to verify decontamination effectiveness. 3. Service Contract.	1. Weekly 2. Every 6 months 3. Annually	Log book
Microbiological incubators, and water baths	1. Thermometers in each unit are immersed in liquid to the appropriate immersion line 2. The thermometers will be graduated in increments of 0.5°C (0.2°C increments for tests which are incubated at 44.5°C) or less	Temperatures are verified prior to introducing samples for incubation and prior to removing samples.	Worksheet/log book
DO meter/probe	1. Calibrate as specified in SOP 2. Maintenance as specified by manufacturer	1. Before use 2. As needed	Worksheet

Table 5.5.13-2 Calibration Acceptance Criteria for Support Equipment				
Equipment	**Type of Calibration/ Number of Standards**	**Frequency**	**Acceptance Limits**	**Corrective Action**
Balance	**1. Accuracy determined using NIST traceable weights.** **2. Minimum of 2 standards bracketing the weight of interest.** **3. Inspected and calibrated by A2LA accredited technician.**	**1. Daily, before use.** **2. Daily, before use.** **3. Annually**	**1. Analytical balance:** <0.5000g **± 0.5mg** ≥0.5000g **± 0.1%** **Top loading balance:** **<1g ± 0.02g** **≥1g ± 2%**	**Clean, check level, insure lack of drafts, and that unit is warmed up, recheck. If fails, call service.**
Thermometer	**Against NIST-traceable thermometer**	**Annually.**	**± 5°C**	**Update correction factor. Replace if outside limits.**
Infrared Temperature Guns	**Against NIST-traceable thermometer**	**Daily before use**	**± 2°C**	**Repair/replace batteries**
Volumetric Dispensing Devices **(Eppendorf ® pipette, automatic dilutor or dispensing devices)**	**Five deliveries at top and bottom of range, by weight.** **Using DI water, dispense into tared vessel. Record weight with device ID number.**	**Quarterly**	**± 1% accuracy and precision at nominal / top of range;** **± 2% accuracy and precision at bottom of range**	**Adjust. Replace.**

(b) (4)

[redacted]

Attachment C-4

Data Management Plan

Data Management Plan
Riverbank Characterization Work Plan
Terminal 4 Action Area
Portland, Oregon

Prepared for: Port of Portland

September 4, 2020
2372-**07**

Table of Contents

1.0 Introduction

This Data Management Plan (DMP) provides the data management process and procedures for the performance of work activities associated with data collection and reporting for the riverbank characterization for the Terminal 4 Facility (T4), located on the east bank of the Willamette River between river miles (RM) 4.2 and 5.0 in Portland, Oregon, and surface sediment sampling in an area that was inaccessible during the T4 Pre-Remedial Design Investigation (PDI) conducted in 2019 by Anchor QEA (Anchor) (Anchor, 2019b). The data collection is described in the Riverbank Characterization Work Plan (Work Plan). That Work Plan was prepared in accordance with the United States Environmental Protection Agency (EPA) Guidance for Riverbank Characterizations and Evaluations at the Portland Harbor Superfund Site (the Guidance; EPA, 2019). The Guidance is to be considered for source control and remedial design processes for riverbanks within the Portland Harbor Superfund Site (PHSS). This work is being performed under an Administrative Settlement Agreement and Order on Consent (ASAOC; Docket No. Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] 10-2004-0009) between the U.S. Environmental Protection Agency (USEPA) and the Port of Portland (Port), as amended on June 21, 2018, and in the Remedial Design Statement of Work (SOW; USEPA 2018). The procedures and policies described in this DMP are consistent with the National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300.

1.1 Project Background

The Port is conducting a riverbank characterization within the T4 in Portland, Oregon, under the direction of the USEPA. This DMP describes the data management procedures to support riverbank characterization and surface sediment sampling and is Attachment C-4 to the Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) for the Work Plan.

The purpose of the riverbank characterization is to evaluate whether bank erosion and transport are a significant pathway for recontamination of the Willamette River PHSS sediments. Consistent with the Guidance, riverbank characterization requires the chemical and physical characterization of the riverbank. Chemical characterization includes the development of a detailed conceptual site model (CSM) based on a review of existing site information and previous investigations. The CSM is used to guide the sampling and analysis plan to delineate the nature and extent of contamination in the riverbank relative to applicable screening criteria. Following the chemical characterization, the riverbank will be characterized for erodibility potential.

The purpose of the surface sediment sampling is to complete the sampling and analysis described in the Pre-Remedial Design Investigation (PDI) Work Plan (Anchor, 2019a). The sediment sampling is intended to refine the understanding of the nature and extent of contamination in the surface sediments (i.e. 0 to 30 centimeters [cm] below the mudline [bml]). Results will be used to refine the lateral extent of contamination and further delineate sediment management areas (SMAs).

1.2 Data Management Objectives

This DMP describes the management of data resulting from field investigations conducted during the riverbank characterization and surface sediment sampling under approved work plans and SAP/QAPPs. The DMP may be revised, amended, and updated as the riverbank characterization and/or surface sediment sampling process evolve and additional riverbank characterization and/or surface sediment sampling activities are identified.

2.0 Personnel

This section describes the key project personnel, training requirements, and describes the roles and responsibilities of each team member.

2.1 Project Personnel

Responsibilities of the team members, as well as laboratory project managers, are described in Section 12.15 of the SAP/QAPP. Project roles specific to implementation of this DMP are described in Section 2.3 of this document.

The Apex Quality Assurance/Quality Control (QA/QC) Manager will manage field and laboratory data records, including electronic data deliverables (EDDs). Only trained, authorized data managers have privileges to load and update data in the central database. Only trained, authorized developers have privileges to develop and modify applications and reporting code used in the data management system. Designated staff will be responsible for the storage and security of project hard copy and electronic files. The Apex QA/QC Manager will be responsible for QA of the analytical chemistry data and records, database and applications.

Project records will be accessible only to approved project personnel.

2.2 Training

Staff involved in data management tasks will have appropriate training in data and document stewardship, including the principles and procedures described herein, and in the systems that are used to manage electronic data. Data management systems comprise both hardware and software, as well as electronic file storage systems. Applications may be commercially or publicly available products or custom software developed by Apex and are used for data collection, data processing, data storage, data analysis, and data reporting. The data management systems that are used to support this project are described in Section 4. The procedures used during data management are described in Section 5.

Training includes formal academic or professional accreditation coursework, as well as internal training developed by Apex expressly for its data management systems.

Staff that have access to data-related applications will have been trained in the proper use of those applications. Staff that develop code will have been trained in standard programming techniques and practices. Staff that manage databases will have been trained in the proper use of database-related hardware (database servers) and software.

2.3 Roles and Responsibilities

The data management roles and responsibilities of the staff involved in data-related activities are as follows.

- Project Manager—Responsible for maintaining direct lines of communication between Apex and the Port, implementing activities described in this DMP, producing project deliverables, and performing the administrative tasks needed to ensure timely and successful completion of the work. The (Apex) Project Manager will provide the overall programmatic guidance to support staff and will ensure that documents, procedures, and project activities meet the objectives contained within this DMP. The Project Manager is also responsible for the review and oversight of project plans and revisions to the plans to maintain proper QA throughout the investigation; field audits, data processing QC, data quality review, and identifying corrective actions.
- Database Analyst (Apex Project Scientist)—Responsible for loading field and laboratory analytical EDDs, performing database quality checks, updating the database as necessary, comparing database records against laboratory hard copy reports, and running reports from the database.
- Field Lead (Apex Project Scientist/Engineer)—Responsible for the documentation of proper sample collection protocols, sample collection, field data collection, equipment decontamination, and chain-of-custody (COC) documentation. The Field Team Staff is also responsible for the proper use of field data collection applications and equipment, and the review of field notebooks, COC records, sample labels, and other field-related documentation.
- Quality Assurance/Quality Control (QA/QC) Manager—Primary point of contact with the analytical laboratory(ies), responsible for laboratory procurement and monitoring of progress, reviewing laboratory receipt acknowledgments and COCs, and reviewing data for quality issues. In addition, the QA/QC Manager is responsible for managing the data validation task, including ensuring that validation of analytical data is conducted and documented according to the requirements of the SAP/QAPP, and coordinating the QA/QC efforts between Apex and subcontractors, including analytical laboratories. The QA/QC Manager is further responsible for data management oversight, including responsibility for database management functions, database quality, data transformations and calculations, applications functionality, data reporting, providing qualifiers and any other edits resulting from data validation to the Database Analyst.

- Laboratory Project Manager—Acts as the primary point of contact at a laboratory facility for the QA/QC Manager to communicate and resolve sampling, receipt, analysis, and storage issues.

3.0 Project Documentation and Records

This section describes the types of documentation that will be included for project-specific and historical datasets, the databases that will be used, how the data will be archived, and database input requirements.

3.1 Project Data

This section describes the documentation and record keeping requirements for field-related data collected during the riverbank characterization and surface sediment sampling process, in accordance with the SOW (USEPA 2018).

3.1.1 Document Types to be Created or Collected

Field data will be documented and recorded in various ways during the riverbank characterization and surface sediment sampling. The following list shows the kinds of field documents and records that may be produced during project data-gathering activities (additional information regarding the maintenance of project documents and records is provided in SAP/QAPP Section 6.0):

- COC records
- Communication logs/emails
- Corrective action communications
- Documentation of corrective action results
- Field change request forms
- Deviation forms
- Documentation of internal QA reviews and/or audits
- EDDs
- Field data collection forms
- Sampling notes in bound, waterproof field log books
- Field instrument calibration logs
- GPS files
- Identification of QC samples
- Identification of USEPA split samples
- Photographs
- Sampling location figures (based on targeted and actual coordinates)

These records will be created in either written (e.g., sampling notes) or electronic formats (e.g., GPS files, measurement instrument/data-logger files, and field databases).

3.1.2 Database for Field and Analytical Data

Apex will maintain field and analytical data in Apex environmental data management system. This system will contain information about locations, field measurements, samples, and laboratory tests and results. Access to the database will be restricted to data management personnel. In general, project personnel will have the ability to view, but not modify, the data. The ability to add or correct data will be granted to only those individuals identified by the QA/QC Manager and trained to perform those tasks.

3.1.3 Project Data File Archives

Original field data documents will be archived in Apex's project files (e.g., field sheets, hard copy maps, and field log books) and electronic files (e.g., field data collection applications, electronic data logger files, GPS files, and photographs) will be archived on a secured server in a project- dedicated folder and/or on Apex's SharePoint site using an appropriate file type (e.g., Standard Storage Format [SSF] for GPS files; Tagged Image File Format [TIFF] or Joint Photographic Experts Group [JPEG] for photographs; and Excel or InfoPath formats for electronic field forms). In addition, all paper field records will be scanned and stored electronically (as portable document format [PDF] files) with other project electronic files, as indicated above. Documents (including records or documents in electronic form) will be maintained at Apex offices or at the Port for a minimum of 10 years after USEPA's notification of completion of work, in accordance with the retention of records section of the ASAOC (USEPA 2003).

3.1.4 Field Electronic Data Deliverables

Field data will be uploaded to the data management system into one or more field EDD formats that are generated from field data collection applications or by transcription from hand-written field forms. Data transferred from written records to field data EDDs will be reviewed against field records prior to being loaded into the database. The EDDs will be checked for valid values and proper format and will be rejected prior to loading if there are errors. The data management system is configured to require that all field samples (normal environmental as well as field QC samples) must be present in the database prior to the loading of laboratory results for those samples to avoid sample identification discrepancies between field and laboratory records.

3.1.5 Laboratory Electronic Data Deliverables

For analytical data, each laboratory will provide an EDD and one copy of a Level 4, contract laboratory program type data package (unless otherwise specified in the SAP/QAPP). While each laboratory is responsible for ensuring all data reported in the electronic copy and data package match, as part of data quality review, Apex will compare a subset of laboratory packages for consistency between EDDs and data package reports. The data deliverable will include a summary package that contains, at a minimum, the case narrative, custody documentation, method citations, field and laboratory sample identifiers cross-reference, sample results (including all raw data needed to support those results), preparation and analysis dates, and summary QC forms. The data package will be provided to Apex as a bookmarked PDF file.

Complete, paginated data packages will contain the following minimum information:

- A narrative addressing any difficulties encountered during sample analysis and a discussion of any exceedances in the laboratory QC sample results
- A cross-referenced table of field and laboratory identification numbers.
- Analytical method references
- Definition of any data flags or qualifiers used; a list of valid data flags and qualifiers will be provided by Apex following contract award
- A table of contents for the data package similar to the USEPA Complete Sample Delivery Group File Audit Checklist
- A COC signed and dated by the laboratory to indicate sample receipt; the temperature of the cooler upon receipt will be noted on the COC or on a sample receipt form
- Results for each field sample, blank and QC sample in units appropriate to the method; method detection limits, estimated detection limits, and reporting limits will also be provided
- Dilution factors for each sample or analyte
- Calibration data, including raw data; initial calibration curve data, such as linear regression statistics or average relative response factors and percent relative standard deviation; continuing calibration data, such as relative response factors and percent difference data
- Gas chromatography/mass spectrometry and inductively coupled plasma/mass spectrometry tuning data
- Internal standard data
- Surrogate (system monitoring) data
- Inductively coupled plasma (ICP) inter-element correction factors, linear range data, serial dilution data, and interference check sample results
- Copies of laboratory notebook pages or preparation logs showing sample preparation documentation
- Field sample results and raw data (chromatograms and ICP printouts), including dilution data
- Laboratory QC data, including method blank data, laboratory duplicate data reported as relative percent difference (RPD), laboratory control spike data, reported as percent recovery; matrix

spike/matrix spike duplicate data reported as percent recovery with RPD calculated; all associated raw data must also be provided

- Copies of phone logs, faxes, and emails associated with the sample set
- Any other data necessary to conclusively confirm the analytical results reported and the overall quality of the data

Apex has an analytical chemistry EDD specification that will be provided to each laboratory. The specification includes a descriptive memorandum, an EDD template, and a current file of valid reference values. Verification of EDD formatting and completeness will be performed by Apex data management personnel during upload or by automated EDD checking and loading procedures. Laboratory EDDs that do not meet the EDD specification or contain errors will not be loaded to the database and will be returned to the laboratory for correction and resubmittal.

3.2 Historical Data

It is anticipated that certain historical tabular datasets (primarily related to analytical chemistry) will be complied into the project database to facilitate the analysis and interpretation of data during the riverbank characterization sampling. This list will be updated as data to document any assumptions, rules, or backfilling of missing data that was needed to enter the data into the master database. The historical datasets will be flagged to distinguish them from new data collected for the project. The historical data will be organized by age and data quality (e.g., detection limits) to facilitate analysis. Historical datasets will likely be complied into the project database via the EXCEL format to facilitate database field mapping and completeness checks. It should be noted that these datasets were developed by others, and the project team is not the owner of the data. Accordingly, the historical dataset will be used “as is” apart from some data “cleanup” actions necessary to normalize and synthesize the disparate historical datasets into a consistent database.

3.3 Document Retention

Original field data documents (e.g., field sheets, hard copy maps, and field log books) will be archived in Apex’s hard copy project file storage facility or at the Port. Electronic files (e.g., field data collection applications, EDDs, electronic data logger files, electronically produced documents, GPS files, and photographs) will be archived on a secured server in a project-dedicated folder using an appropriate, standard file type (e.g., PDF, SSF for GPS files, and TIFF or JPEG for ASAOC [USEPA 2003]). Specifically, until 10 years after receipt of USEPA’s notification of completion of work, the Port (and its contractors) shall preserve and retain at least one copy of all records and documents (including records or documents in electronic form) now in its possession or control or which come into its possession or control that relate in any manner to the performance of the riverbank characterization and surface sediment sampling work or the liability of any person under CERCLA with respect to the T4 Removal Action Area, regardless of any internal retention policy to the contrary. Non-identical copies of documents will be maintained for a minimum of 10 years. Documents include hard copy documents, records, and other information in electronic form. Retention standards for documents created by subcontractors will be communicated to the subcontractors during contracting.

4.0 Data Management Systems

The environmental data management system is composed of a number of hardware and software components, as described herein. System hardware includes servers and storage devices, computers and tablets, and networking and internetworking devices. Software includes operating systems, server and data storage applications, user data access and analysis applications, and field data collection applications.

4.1 Hardware

The hardware systems that comprise the data repositories include file servers and database servers. Key elements of these systems, specifically the analytical chemistry database and the spatial data displays, are housed in a physically and electronically secure data center on enterprise-level hardware. The data center is remotely located and equipped with redundant power supplies and internet connections. Access to systems hardware and software in the data center is limited to designated, authorized personnel. File servers used to store and share project documents are either maintained on premises in a physically and electronically secure, dedicated server room or use cloud-based storage systems. Only designated personnel have access to project folders and files on file servers.

The networks within which servers reside are protected by firewalls and more than one level of malware detection and protection software and includes coverage for email servers, networks, and computers.
Computers and tablets used in field activities are dedicated to such activities and are secured by login requirements. Data stored on computers, tablets, GPS devices, and instrument data loggers will be exported and stored in project file servers as soon after each field activity as is practical; USB flash memory devices may be used for intermediate, temporary data storage in the field. Project data will not be commingled with data from other projects. Data will be stored in raw form (in the format in which it was generated) and in EDD formats suitable for loading to the project database.

Some in situ sensors may telemeter data to a third-party vendor. In such cases, these data will be accessible from a password-protected website. Data will be downloaded to the project file server for storage.

4.2 Software

Licenses and active software maintenance agreements, where applicable, are required for all computers used in project work. Operating systems on servers and computers are updated with security and functional patches as provided by vendors after internal evaluation. Licensed applications are used for the database management system and the Geographical Information System (GIS). The database management system is Microsoft Excel 2016. The GIS is Esri ArcGIS version 10.8. The data models and software for these systems are proprietary to the vendor and cannot be shared.

5.0 Data Management Procedures

This section describes the procedures for handling and tracking project data and documents.

5.1 Field Data Quality Review

QC checks will be performed as soon after field activities as is practical. The checks and the person responsible for performing them are outlined as follows:

1. Review field records for completeness and accuracy of information reported on field forms or in electronic applications with respect to requirements specified in the SAP/QAPP (Field Lead).
2. Ensure that corrections are made. For hard copy forms, corrections will be made with a single strikethrough and each corrected entry will be signed or initialed and dated. For electronic data, corrections are made in the application or in the EDD (Field Lead).
3. Compare field activities against the SAP/QAPP (Field Lead).
4. Scan hard copy forms and place scanned forms and electronic files into project-specific folders in the file server (Field Lead).
5. Review field records for conformance to standard nomenclature defined in SAP/QAPP (QA/QC Manager).
6. Review in situ sensor data logger files for instrument issues (Field Lead).
7. Verify GPS coordinates (Field Lead).
8. Review COCs and laboratory receipt acknowledgments (QA/QC Manager).
9. Ensure that project documents are properly saved in project folders (QA/QC Manager).

The Field Lead and QA/QC Manager, as appropriate, will be responsible for ensuring that corrections are made in response to issues identified in the steps above.

5.2 Field Data Processing

Procedures for field data collection and creation of field records are described in the SAP/QAPP. Management of these data are described as follows.

Field data are processed according to the following general steps. These may be performed after QC checks are completed but may be performed with unverified field data in support of the QC steps outlined in Section 5.1.

1. Send GPS files with coordinates to Apex GIS drafter (Field Lead).
2. Prepare field EDDs. Applicable field forms will be transcribed and stored in the project database into specifically formatted, Microsoft Excel field EDD templates. Otherwise, field forms will be stored in appropriate EDD format and saved in project-specific folders in the file server (Field Lead).
3. Place hard copy files, data logger files, and image files in designated project folders (Field Lead).
4. Load field EDDs to the database (Database Analyst).

Field EDDs will include, at a minimum and as specified in the project SAP/QAPP, the following items:

- Location information (e.g., location identifier, coordinates [in the appropriate project coordinate system], depth or elevation with units in the appropriate datum)
- Soil sample information (e.g., date/time, location, depth[s], sample type, geologist, lithology, and, if duplicate, the associated normal parent sample)
- Sediment sample information (e.g., date/time, location, depth, sample collection method, water depth, river gauge elevation, presence of aquatic organisms, and compositing information, as required)
- Visual observations
- COC/test request information

5.3 Laboratory Data Processing and Data Validation

The following steps are performed on data received from laboratories or from data validators. COCs, laboratory receipt acknowledgements, laboratory reports and EDDs, and data validation reports and EDDs are stored in designated project files. If any revisions to these files are made, the original files are retained.

- Coordinate with laboratory regarding schedule, issues, and receipt of data (QA/QC Manager).
- Load laboratory EDDs to the database (Database Analyst).
- Prepare validation export EDD (Database Analyst).
- Perform data validation. This step may be performed in-house or sent to a subcontractor for validation (Database Analyst).
- Review validation results. This step is performed regardless of whether validation is performed in-house or by a subcontractor (QA/QC Manager).

- Load validation results (Database Analyst).
- Review database records against laboratory report for consistency (Database Analyst).
- Perform any data transformations or processing necessary to support data analysis (Database Analyst).

Apex's laboratory analytical EDD loader applications can be configured to perform several completeness and quality checks. To assist laboratories with Apex's EDD requirements, documentation of laboratory EDD specifications is provided to project laboratories during laboratory contracting or before the inception of the project. Analytes, including target, surrogate, and other method-specific QC analytes, as well as matrices and units must be reported as stated in the project SAP/QAPP. A laboratory EDD will not be loaded to the database if it does not, at a minimum, match the proper EDD file-naming convention, formatting, valid values, and field sample identifier. Depending on the laboratory and the tests requested, the loader application may require that all analytical reporting requirements have been met before accepting the EDD. Any errors will be communicated to the laboratory by the QA/QC Manager, and it is the responsibility of the laboratory to submit a proper EDD. All revisions of EDDs are maintained in designated project folders.

The QA/QC Manager will review laboratory data packages for proper formatting and completeness, as specified in the project SAP/QAPP. Any errors will be communicated to the laboratory for revision and resubmittal.

Data validation will be performed as required in the project SAP/QAPP. The QA/QC Manager will be responsible for ensuring that validations are performed properly and at the required frequency and level of evaluation. The QA/QC Manager will also be responsible for the preparation and loading of validation EDDs, ensure that validation reviews are performed.

The final analytical data quality review is a verification of database records against laboratory and validation reports. This step is performed by the QA/QC Manager. When data passes this step, they are ready for evaluation and analysis by project personnel and ready for reporting and transmittal to other parties.

Apex records the status and workflow of laboratory and data validation deliverables at the sample delivery group level in a custom tracking application, from laboratory receipt acknowledgement to final data quality review by recording the date and person that completed each step in the process.

5.4 Geospatial Data

Geospatial information will be stored in an Esri geodatabase system. Spatial data (ex: GPS data point) will be transmitted in the using local geographic coordinates.

The Field Lead will oversee field-generated coordinate verification procedures and will work with the QA/QC Manager to ensure that accurate, verified coordinates are stored with location information in the project database.

5.5 Imagery

Photographic and videographic image files may be created in this project. Original files, produced by equipment suitable for the quality objectives, will be retained unedited in project folders. Edited files will be stored as revisions.

5.6 Database Modifications

Modifications to the database after final data quality review, while rare, may occur. These may occur after holistic review of the data during evaluations that may reveal issues with the data not detected during the formal data validation process. Potential issues will be discussed with the Project Manager prior to modifying the database. Modifications may occur after data have been transmitted. A project database change log is maintained that records the release or transmittal dates of a dataset and the dates and nature of changes made to the database.

Notification of database modifications to affected parties will be made through email or a memorandum as soon as is practicable.

6.0 Data Protection and Security

The information systems that contain and support project data, including field and analytical data as well as other electronic information, include systems within Apex's offices, in a data center facility, and an off-site storage location for tape backups. The procedures that protect and secure these information systems are described below.

6.1 Computer Systems

Servers in Apex's facilities are physically secured in locked buildings and rooms, with access limited to authorized personnel. Servers are electronically secured behind firewalls with multiple layers of anti-malware software that protect the firewall, the local area networks, and emails. Servers and networking equipment are connected to battery-based uninterruptable power supplies with automated shutdown procedures in the event of a power outage.

Operating system and third-party software are licensed and maintained with vendor-supplied security patches. Major updates are evaluated and tested, and project managers are consulted regarding the impact of major updates prior to deployment on production servers.

Access to these servers is limited to authorized system administrators through physical locks and through network domain permissions. Access to central data management systems is limited by permissions to authorized project-specific data management personnel.

6.2 Physical Files

Physical files stored on premises or in an off-sight storage facility are physically protected to the extent practicable by security systems and fire prevention systems. Historical documents and images will be protected from light to prevent damage. To the extent practical, physical documents will be scanned, and those scanned documents will be protected through electronic storage backup systems.

6.3 Privacy and Confidentiality

It is not anticipated that the data collected will pose privacy concerns. Once data and documents are reviewed for quality, as described elsewhere in this document, they will be transmitted to USEPA. No data generated during this project are considered confidential. Proprietary software used to evaluate data are considered confidential.

7.0 Data Reporting and Transmittal

Reporting and the submittal of data to USEPA will be performed as specified in the SOW (USEPA 2018).

7.1 Sampling, Monitoring, and Analytical Data

As specified in the SOW (USEPA 2018), analytical chemistry and field monitoring data along with sample and location information from the riverbank soil and sediment sampling event will be provided, following validation, to USEPA in a T4 Riverbank Characterization Summary Report.

7.2 Spatial Data

Spatially referenced and geospatial data will be submitted as specified in the SOW (USEPA 2018). Project-generated feature classes, as appropriate, will include an attribute name for each T4 Action Area unit or sub-unit, as applicable. Spatial data will be transmitted in the Esri File Geodatabase format using local geographic coordinates.

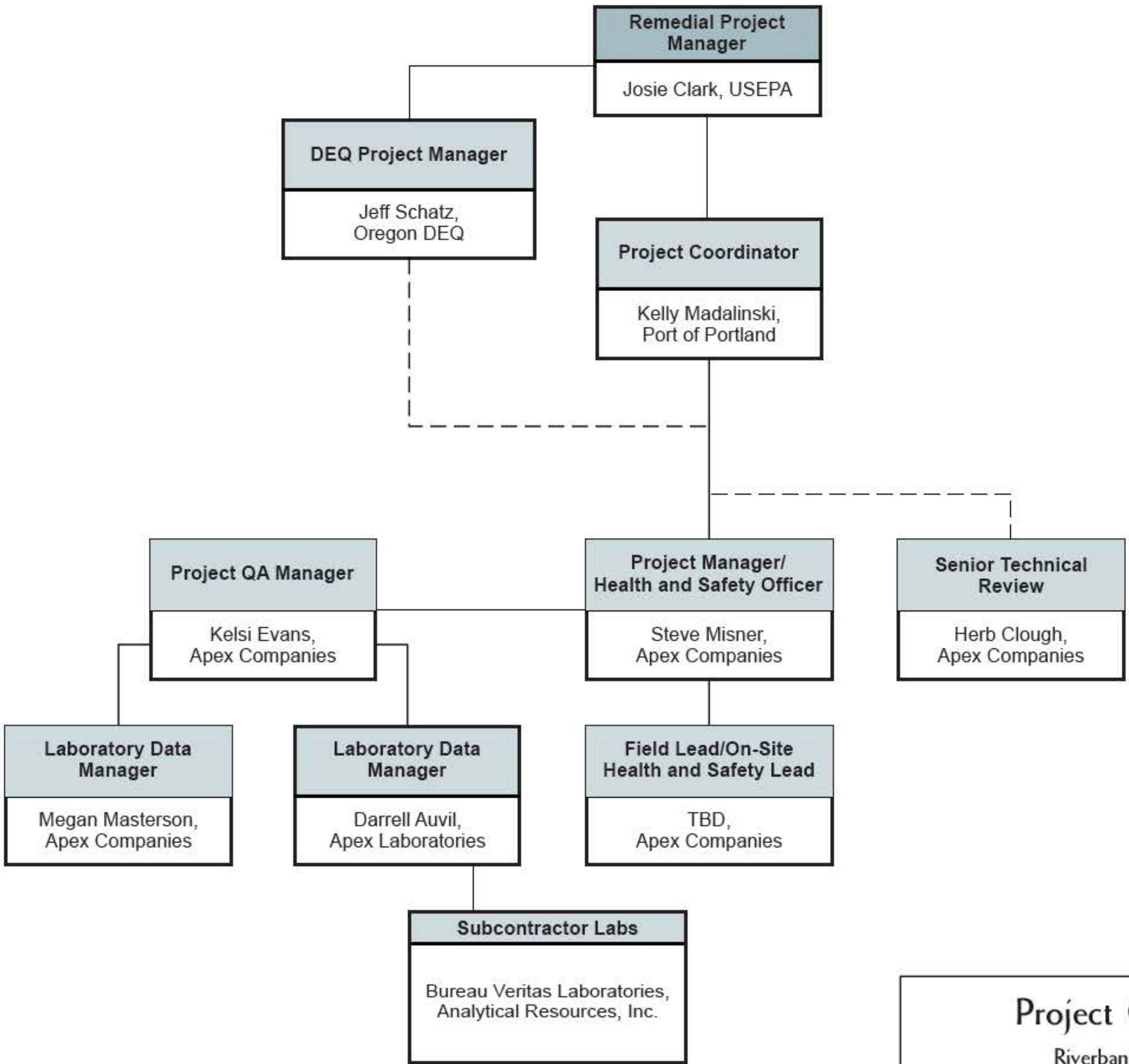
8.0 References

USEPA (U.S. Environmental Protection Agency), 2003. Administrative Order on Consent for Removal Action in the Matter of Portland Harbor Superfund Site, Terminal 4, Removal Action Area, Portland, Oregon.

USEPA, 2018. Remedial Design Statement of Work, Portland Harbor Superfund Site, Terminal 4 Action Area, Portland, Multnomah County, Oregon, EPA Region 10. June 2018.

Attachment C-5

Project Organizational Chart



Notes: **Bold** Indicates Task Leader
——— Primary Communication Line
– – – Secondary Communication Line

Project Organizational Chart

Riverbank Characterization Work Plan
Terminal 4 Action Area
Portland, Oregon

APEX
Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

Project Number	2372-07	Figure
September 2020		C-5

Appendix D

Riverbank Reconnaissance Photographs

ATTACHMENT D
PHOTOGRAPH LOG

Project Name: Riverbank Characterization Work Plan
Client: Port of Portland
Project Number: 2372-07
Location: Terminal 4 Action Areas

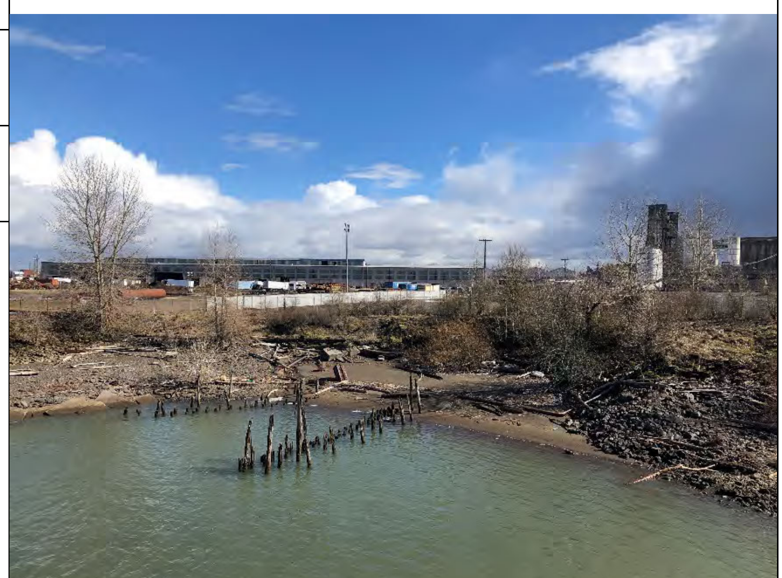
Photo Station:	1
Photo Date:	5/20/2019
Orientation:	East
Description:	

North end of Berth 401.

Dense vegetation on the upper section with rip rap below.

Photo Station:	2
Photo Date:	5/20/2019
Orientation:	East
Description:	

North end of Berth 401



ATTACHMENT D
PHOTOGRAPH LOG

Project Name: Riverbank Characterization Work Plan
Client: Port of Portland
Project Number: 2372-07
Location: Terminal 4 Action Areas

Photo Station:	3
Photo Date:	5/20/2019
Orientation:	East

Description:

Head of Slip 3

Small area of erodible soil observed near a recently installed sign.

Photo Station:	4
Photo Date:	5/20/2019
Orientation:	North

Description:

Riverside of Slip 3

Concrete retaining wall with vegetation and rip rap below. Erodible soil observed in gap between wall and rip rap.

ATTACHMENT D
PHOTOGRAPH LOG

Project Name: Riverbank Characterization Work Plan
Client: Port of Portland
Project Number: 2372-07
Location: Terminal 4 Action Areas

Photo Station:	5
Photo Date:	5/20/2019
Orientation:	East

Description:

South end of Berth 401

Concrete retaining wall at top with wooden retaining wall with concrete posts below. Areas of erodible soil observed where wooden retaining wall has failed.

Photo Station:	6
Photo Date:	5/20/2019
Orientation:	North

Description:

North side of Slip 1.

Dense vegetation on the upper section with wooden retaining walls with areas of failure.

ATTACHMENT D
PHOTOGRAPH LOG

Project Name: Riverbank Characterization Work Plan
Client: Port of Portland
Project Number: 2372-07
Location: Terminal 4 Action Areas

Photo Station:	7
Photo Date:	5/20/2019
Orientation:	North
Description:	

North side of Slip 1.

Area of failing wall repaired with rip rap.

Photo Station:	8
Photo Date:	5/20/2019
Orientation:	Northeast
Description:	

Berth 405.

ATTACHMENT D
PHOTOGRAPH LOG

Project Name: Riverbank Characterization Work Plan
Client: Port of Portland
Project Number: 2372-07
Location: Terminal 4 Action Areas

Photo Station:	9	
Photo Date:	5/20/2019	
Orientation:	North	
Description: Berth 405. Wooden retaining wall behind berth with approximately the same failure rate as other areas.		

Photo Station:	10	
Photo Date:	5/20/2019	
Orientation:	South	
Description: Former Berth 412. Failure of wooden retaining walls with dense vegetation on the upper section.		

ATTACHMENT D
PHOTOGRAPH LOG

Project Name: Riverbank Characterization Work Plan
Client: Port of Portland
Project Number: 2372-07
Location: Terminal 4 Action Areas

Photo Station:	11
Photo Date:	5/20/2019
Orientation:	South
Description:	Former Berth 412. Concrete supports left after failure of wooden retaining walls.

Photo Station:	12
Photo Date:	5/20/2019
Orientation:	Southwest
Description:	South side of Sip 1. Native trees and shrubs on the top of bank planted as part of restoration work. Erosion on lower slope.

ATTACHMENT D
PHOTOGRAPH LOG

Project Name: Riverbank Characterization Work Plan
Client: Port of Portland
Project Number: 2372-07
Location: Terminal 4 Action Areas

Photo Station:	13	
Photo Date:	5/20/2019	
Orientation:	Southwest	
Description: South side of Slip1. Native trees and shrubs on the top of bank planted as part of restoration work. Erosion on lower slope.		

Photo Station:	14	
Photo Date:	5/20/2019	
Orientation:	East	
Description: Berth 409. Concrete low dock with dense vegetation on both sides.		

ATTACHMENT D
PHOTOGRAPH LOG

Project Name: Riverbank Characterization Work Plan
Client: Port of Portland
Project Number: 2372-07
Location: Terminal 4 Action Areas

Photo Station:	15
Photo Date:	5/20/2019
Orientation:	East
Description: Riverside of Slip 1. Rip rap armor on the lower slope and established vegetation on the upper slope.	

Photo Station:	16
Photo Date:	5/20/2019
Orientation:	
Description: Wheeler Bay. Riverbank stabilization actions completed in 2008. Rip rap and woody debris on lower slope and vegetation on the upper slope.	

ATTACHMENT D
PHOTOGRAPH LOG

Project Name: Riverbank Characterization Work Plan
Client: Port of Portland
Project Number: 2372-07
Location: Terminal 4 Action Areas

Photo Station:	17
Photo Date:	5/20/2019
Orientation:	North
Description: Berth 411. Riverbank beneath pier stabilized with rip rap.	

Photo Station:	18
Photo Date:	5/20/2019
Orientation:	East
Description: Head of Slip 3. Riverbank stabilization actions completed in 2004. Rip rap on the lower slope and vegetation on the upper slope.	

Approval Page

U.S. Environmental Protection Agency, Region 10

Josie Clark 10/15/2020

Josie Clark, Regional Project Manager *Date*

Port of Portland

Kelly Madalinski, Project Coordinator *Date*

Apex Companies, LLC

Steve Misner 9/4/2020

Steve Misner, Project Manager *Date*

Apex Companies, LLC

Kelsi Evans 9/4/2020

Kelsi Evans, Quality Assurance Manager *Date*